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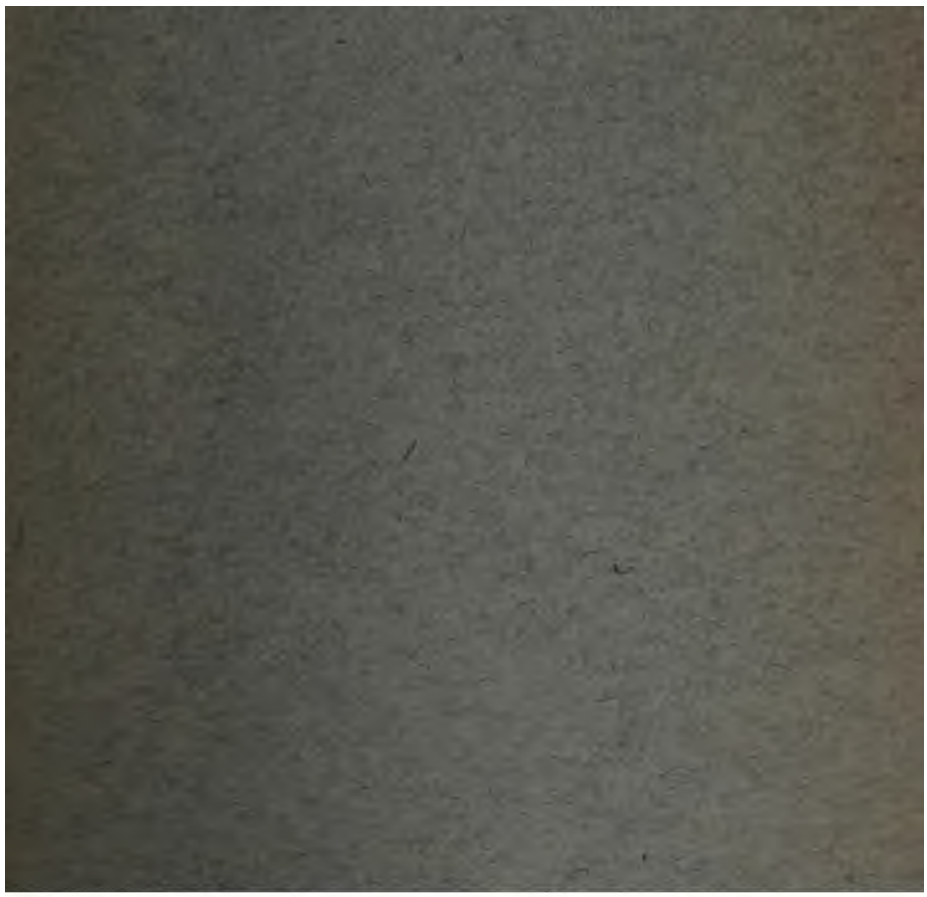

TRANSACTIONS

OF THE

Royal Geological Society

OF

CORNWALL.

INSTITUTED FEBRUARY 11th, 1814.

VOLUME THE TENTH.

"A knowledge of our subterranean wealth would be the means of furnishing greater opulence to the country than the acquisition of the mines of Mexico and Peru."

President of the Board of Agriculture.

PENZANCE:
SOLD AT THE APARTMENTS OF THE SOCIETY.
1887.

CONTENTS.

ANNUAL REPORTS.

SIXTY-FIFTH ANNUAL REPORT— PAGE

List of Officers, 1878-9 iii
List of Members v
Address of the President, Mr. Warington W. Smyth, F.R.S.
Obituary Notice of Mr. Charles Fox . . . xi
„ Sir F. M. Williams . . xiii
„ Sir R. Griffith, F.R.S. . . xiii
„ D. Oldham, F.R.S. . . . xiv
„ Captain J. Vivian . . . xv
Arrangement of the Palæontological Collections of the Society, by Mr. Etheridge, F.R.S. . . . xv
Mineral Collections in the Paris International Exhibition xvii
Tin Production in Queensland, New South Wales, Bangka, Blitong, and Sumatra . . . xvii
Edible Clay xix
Cyprus, and its Metallic Products . . . xx
Report of the Council xxvii
Librarian's Report xxix
Curator's Report xxxiii
Treasurer's Statement xxxix
List of Papers read at the Annual Meeting.

SIXTY-SIXTH ANNUAL REPORT—

List of Officers, 1879-80 xliii
List of Members xlv
Address of the President, Mr. Warington W. Smyth, F.R.S.
Obituary Notice of Sir R. Vyvyan . . . li
„ Mr. S. Higgs . . . liii
„ Professor Von Cotta . . liii
„ Mr. T. Sopwith . . . lv
„ Captain W. Vivian . . . lv

PAGE

The Rocks of the Penwith District . . . lvi
Mr. J. Arthur Phillips on Cornish Rocks . . lvii
Mr. Allport on the Metamorphic Rocks of the Land's End District lx
Mr. Allport on the Serpentine of Clicker Tor . . lxi
Mr. Ussher on the Quarternary Geology of Cornwall lxi
Professor Daubrèe on Stanniferous Deposits . . lxii
Report of the Council lxv
Librarian's Report lxix
Curator's Report lxxiii
Treasurer's Statement lxxv
List of Papers read at the Annual Meeting.

SIXTY-SEVENTH ANNUAL REPORT—

List of Officers, 1880–81 lxxix
List of Members lxxxi
Address of the President, Mr. A. Pendarves Vivian, M.P., F.G.S.
Obituary Notices of Mr. John Michael Williams, Mr. Edward Rodd, Rev. M. N. Peters, and Mr. John Jope Rogers lxxxviii
Plumosite and Amazon Stone lxxxix
Fossil Mussels from Coal-beds in South Wales . . xc
The Cribbor Vawr Coal Vein xc
Report of the Council xciii
Librarian's Report xcv
Assistant Curator's Report ci
Treasurer's Statement cvi
List of Papers read at the Annual Meeting.

SIXTY-EIGHTH ANNUAL REPORT—

List of Officers, 1881–82 cxi
List of Members cxiii
Address of the President, Mr. A. Pendarves Vivian, M.P., F.G.S.
The Volcanic District of Mont Dore, Auvergne . cxx
Tertiary Fossils at Clermont Ferrand . . . cxxi
The Formation of the Valleys of Mont Dore . . cxxv
Obituary Notices of Rev. T. England, Mr. James Tennant, the Earl of St. Germans, Mrs. Richard Harvey, and Mr. Day Perry Le Grice . . cxxvi
Report of the Council cxxvii
Librarian's Report cxxix
Curator's Report cxxxix
Treasurer's Statement cxlv
List of Papers read at the Annual Meeting.

Contents.

SIXTY-NINTH ANNUAL REPORT— PAGE

List of Officers, 1882–3 cli
List of Members cliii
Address of the President, Mr. Leonard Courtney, M.P.
The Debt owed in the Present Day to Science . . clx
Special Influence of Geological Study on Mental Training clxi
Report of the Council clxv
Librarian's Report clxvii
Curator's Report clxxv
Treasurer's Statement clxxvi
List of Papers read at the Annual Meeting.

SEVENTIETH ANNUAL REPORT—

List of Officers, 1883–4 clxxxi
List of Members clxxxiii
Address of the President, Mr. Leonard Courtney, M.P.
The Instability of Nature cxc
Earthquakes and Volcanoes cxci
Report of the Council cxcv
Librarian's Report cxcvii
Curator's Report ccviii
Treasurer's Statement ccix
List of Papers read at the Annual Meeting.

SEVENTY-FIRST ANNUAL REPORT—

List of Officers, 1884–85 ccxiii
List of Members ccxv
Address of the President, Mr. Warington W. Smyth, F.R.S.
The Pliocene Deposit at St. Erth . . . ccxxii
Geological Classification and Nomenclature . . ccxxv
Geology and Mining of North America . . . ccxxvi
Pike's Peak ccxxvii
The Nevada Mining District and its Downfall . . ccxxviii
Obituary Notices of Mr. Brittain, Mr. Richard Davey, and Mrs. J. M. Williams ccxxx
Report of the Council ccxxxi
Librarian's Report ccxxxiii
Curator's Report ccxliv
Treasurer's Statement ccxliv
List of Papers read at the Annual Meeting.

Contents.

SEVENTY-SECOND ANNUAL REPORT— PAGE

List of Officers, 1885–86 . . . . . cclı
List of Members ccliii
Address of the President, Mr. Warington W. Smyth, F.R.S.
Obituary Notice of Mr. T. Davidson . . . cclix
The St. Erth Deposit cclx
Mr. Searles V. Wood and Dr. Gwyn Jeffreys . . cclxi
The Eruption of Krakatoa cclxvii
Obituary Notices of Mr. Alfred Lloyd Fox and Mr. Alfred Tylor cclxix
Report of the Council cclxxi
Librarian's Report cclxxii
Curators' Report cclxxxiii
Treasurer's Statement cclxxxiv
List of Papers read at the Annual Meeting.

Royal Geological Society of Cornwall.

THE SIXTY-FIFTH

ANNUAL REPORT,

ETC. ETC.

PENZANCE.
1879.

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The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

In meeting on our anniversary so goodly a gathering of the Royal Geological Society of Cornwall, I trust that my colleagues in the Council and myself will be able to lay before you sufficient grounds for the assertion that, after a well-considered expenditure, our financial position is sound, and that the usefulness of the Institution has been increased by a very decided step in advance.

We have, it is true, to mourn the loss during the past year of two of our members resident in the county, as also of two distinguished geologists among our honorary members.

Of the former class I have only to mention the name of Mr. Charles Fox, of Trebah, to remind every Cornishman that in him we have lost the last of a family of brothers whose good deeds and mental acquirements were known and appreciated far beyond the limits of their own county. It was only last year that I had sorrowfully to bring before you the severe loss we had sustained by the decease of our oldest member, Mr. Robert Were Fox, F.R.S., and I little expected that Mr. Charles Fox, although he had reached the ripe age of eighty, was so soon to be taken from us, such was his apparent youthfulness and freshness of feeling, and such the bright tone with which he was wont until last year to attend and enjoy our meetings. Although not a cultivator of geological science in the field, Charles Fox was a man of very extensive reading in this, as well as other branches of scientific learning; and those who had the advantage of hearing his addresses, when for five successive years (1863 to 1867) he was President of your Society, will recollect the versatility and ease with which he was wont to cull the flowers met with in his studies,

some in one direction, some in another, but made up into a bouquet held together by a string of logical thought, and exhaling the true geological fragrance.

It will be recollected too that Charles Fox, with other members of his family, were the actual founders of the Royal Cornwall Polytechnic Society, whose annual exhibitions at Falmouth have not only encouraged generally the cultivation of Art and Mechanical Construction, but in several instances have been attended with a decisive practical result in some particular direction. Thus the introduction of that great boon to the working miners, the "man-engine," was directly due to the spirited action of Mr. Charles Fox, seconded by other subscribers, in offering a round sum of £600 to the first mining company that would commit themselves to the erection of this expensive novelty. The Tresavean Adventurers were the first to attempt the task, and in 1842 had the satisfaction of seeing their men relieved by this admirable contrivance from the deadly labour of climbing the ladders from those deep workings to the surface.

The Society and Mr. Charles Fox were gratified by the warm thanks of the men employed in that extensive mine, as embodied in a memorial, and thousands of men have in other Cornish mines owed comfort and health to the action thus taken by our late energetic associate.*

Mr. Fox travelled occasionally into the Mediterranean countries, sometimes for his health, but impelled also by the love of geographical knowledge which induced him for years together to offer prizes at the Polytechnic for the drawing of maps—"Lander prizes" he called them, in honour of those spirited African explorers, the brothers Lander, of Truro. It was thus that he gained a personal acquaintance with Algiers and Egypt and the

* It does not detract a jot from the merits of the Society, or of the devisers of the man-engine, but has to be recollected as a fact, that the very same contrivance had been invented in the Hartz several years previously, as I myself can vouch for, from having travelled through some of the shafts in the Hartz mines in the winter of 1839-40, both at Clausthal and Andreasberg, on what is there called the *Fahrkunst* or *Steigkunst*, a double-rod machine shorter in stroke than, but identical in principle with, those erected at Tresavean, and shortly afterwards at United Mines.

Holy Land, which gave him rich material for thought and comparison, to be woven at the proper season into the lectures and addresses which at the meetings of various societies he was always prepared to give with unfailing flow of speech.

To all of us who take an interest in the rise and progress of our Society, it is interesting to know that it was Charles Fox who was chiefly instrumental in starting our late eminent member, Mr. Jory Henwood, on his scientific work. Finding him an industrious young clerk in his office, Mr. Fox used to invite him to his house frequently to study electricity and chemistry with an invalid brother-in-law, and he afterwards united with Mr. Robert Were Fox in arranging for that inspection of mines which led to the publication of your fifth volume, and Henwood's subsequent numerous labours. It needs scarcely to be added that, wherever schemes of benevolence and philanthropy were brought forward, Mr. Charles Fox evinced himself thoroughly one of that family whose name has so long been honourably associated with Falmouth.

The death of Sir Frederick Williams, Bart., M.P., in his best years of activity, has been a great shock, especially to the many who saw him only a short week before his death apparently well and strong, and enjoying the examination of the Polytechnic Exhibition. He was in office this year as one of your Vice-Presidents, and had taken a leading part in various other public bodies in the county. I happen to know instances in which his loss will be much lamented by the labouring classes, and had he been spared to attain an average length of years he would doubtless have filled a sphere of increasing usefulness.

One of the most remarkable persons who adorned your list of honorary members was the late Sir Richard Griffith, Bart., LL.D., F.R.S. Up to the last, in his ninety-fifth year, preserving his bodily and mental activity, this marvellous veteran might look back to a period when geology, as now understood, could not be said to exist—to a date when no Geological Society had yet reared its head. But placed in a position in Ireland of a nature to

exercise his powers of observation and reasoning, there in the early years of the century he worked at some of the most important problems of economic geology. Especially was it the various small scattered coal-fields of central Ireland, which he examined in great detail, and on which he published excellent reports. At the same time, and for years after, gradually organizing a corps of assistants, he collected the materials for constructing a geological map, and thus at a very early period in the history of such enterprises he was able to bring out an admirable map of the geological features of the whole of Ireland—an extraordinary work for a single man, and paralleled, as I believe, in no case, except the original Survey of England by William Smith, and the celebrated map of Belgium by M. Dumont. Sir Richard Griffith, from his thorough knowledge of the country, and from his fairness and probity, was for a long series of years a most valued servant of the Irish Government. Many of the improvements in the social condition of the country people were during the last half-century due in part to his industrious co-operation; and among a Celtic people it is interesting to observe the success with which a Welshman (for he was from Anglesey) accomplished so long and useful a career in Ireland.

Another honorary member, of whom death has deprived us, was also long wellknown in connection with the sister island. Dr. Oldham, F.R.S., about thirty years ago held the Professorship of Geology at Dublin, at the same time that he directed the mapping of the Government Geological Survey in the field. His varied accomplishments and practical knowledge of the kind of work marked him out as a suitable chief for a similar survey of India, and there for many years he has laboured, assisted by an able staff, and keeping up a close connection with European science. The numerous volumes on the shelves of your library—to say nothing of the actual maps and of various other work—testify to the activity of the band of good observers, organized and led by our deceased friend. But, alas! the climate, with the inevitable exposure at times incurred, at length, in spite of occasional visits home, afflicted him with illness which he could not shake off; and

though he returned to England, and hoped when attending the British Association Meeting at Plymouth last year that he might after a time begin to mend, he succumbed a few months later to the persistent disorder.

From the ranks of our Associate members we have lost one who was so fine a type of the old Cornish mine agent, that I desire to record my respect for his worth, and my regrets at not having had the advantage of conferring with him for some time past. Captain Joseph Vivian, of North Roskear, with his manly countenance and his athletic frame, was some years ago the picture of a mine captain; and nowhere, perhaps, would one find in greater perfection the happy union of knowledge of details of work, of foresight and decision, and of sterling common-sense, than in the opinions and conduct which ruled that interesting mine for many years. Joseph Vivian was also known and valued as the toller or mineral adviser of certain lords; and supported by a vigorous constitution, lived, near Camborne, to the age of eighty-six, a length of years very rarely accorded to those who have passed so long a time as he had in deep mines.

We have dwelt for some time on the past; let us now throw a glance upon the present and the future of our Society. Many of you, I trust, in entering through our first room, may have observed the wall-case on the eastern side, erected some months ago, and now filled, fitted, and scientifically ordered by Mr. R. Etheridge, F.R.S., according to the instructions given by your Council, and laid before you as a proposition at our last general meeting. You will remember that whilst the collections of local palæontology, notably the fossils found in Cornish localities of the so-called Devonian system, were lauded as the richest in England, the illustrations of the life of the successive geological periods generally were too meagre to be allowed, in the judgment of an experienced critic, any educational value. In the address which I had the honour to deliver to you last year, I set forth at some length the explanation of this fact, and the steps which it was proposed to take in order to clear this department of our Museum from the

charge of inefficiency. Mr. Etheridge, I am now happy to inform you, with that zeal which he always carries into his scientific work, has obtained from different sources such a series of fossils as in his judgment would be typical of the stratigraphical geology of the British islands, and within the last month has arranged them on your shelves in clear and definite order.

You will now observe that, consistently with their superposition in nature, the newer formations are placed at the top, with their representative forms of life (chiefly the invertebrate) arranged as far as possible zoologically. The more deep-lying formations, or those which form a great part of the surface of central England, are grouped upon the lower shelves, and the organic remains of the older or palæozoic rocks occupy the basement part of the cabinet. Above, therefore, you will begin with the Post-Pliocene, the Pliocene, and the Eocene; below this you will study the characteristic forms of the Cretaceous, the Greensand, Wealden, and the various divisions of the Oolitic or Jurassic system. These, including the Lias, teeming as it is with fossils, are very fully represented; the Trias and the Coal measures more sparingly, although a fair group of the fossil plants of the latter is exhibited. Near the base of the cabinet you will find the forms of the Carboniferous limestone, of part of the Devonian and of the Silurian strata, all these latter groups presenting an unusual degree of interest to naturalists and investigators in the Western counties, from furnishing subjects of comparison with the local formations.

It may then be asserted with confidence that, since this important addition to your Museum, no thoughtful reader, no class of students, need to doubt or to stumble for want of the most essential aid in gaining a practical and, as it were, living knowledge of this branch of geology—that aid being a personal acquaintance with such characteristic forms as will enable us to discriminate the various successive groups of strata, and to appreciate, in some measure at least, the marvellous history of life in past time.

Without instituting comparisons, or reflecting upon other museums, it will be but just to your Council to recognize the fact, that whereas the absence of any exhibition of such a systematic fossil series throughout the south-west of England was much to be

regretted, this Society has now taken the lead in an important advance, and, although at the cost of a large proportion of its moderate income, has acted up to the intention of its founders and friends in thus furthering the progress of scientific education.

The permission accorded by the Society to Mr. Barnett to hold classes for scientific teaching in your spare rooms in the basement of this building has been attended by very satisfactory results. Instruction has been given to a considerable number of students on Inorganic and on Practical Chemistry, Mineralogy, and Geology; and the issue of the examinations under the "Science and Art" Department has been so successful as to redound greatly to the credit both of the instructor and his pupils.

Among the various matters of geological interest during the past year, some prominence may be given to the numerous collections, some of them aided by catalogues or treatises, which formed a part of the marvellous treasures of the Paris International Exhibition. Having had occasion, as a juror, to occupy several weeks in studying its contents, I may boldly aver that so rich and so suggestive were some of these series, notably those of Hungary, Canada, the Australian Colonies, and the Western United States, that they would have afforded ample subject for several geological discourses in succession. More frequently among the various countries the attention would be attracted to a collection of ores and useful substances alone, in others especially to some one more remarkable product. No one, having at heart Cornubian interests, could fail to be deeply impresssed with the witnesses to the indubitable wealth in tin of sundry distant regions, which, by virtue of the facilitated intercourse between remote lands, have poured their produce so largely into the commerce of the world as to occasion, in part at least, that depression and grievous trial which at present afflicts a large portion of our Western population.

Most serious among these were the imports from Queensland and from New South Wales: the piles of ingots of smelted tin, and the solid nature-rolled masses of brown stream tin, from the size of a walnut to boulders as large as a man's head, seemed strongly to confirm the reports of the quantity of the ore and the facility with which it was obtained. Tasmania was not represented;

but the Dutch East Indies, which for many years have played an important part in the production of this metal, exhibited articles of so much interest that I do not hesitate to mention them to you, along with explanatory statements given to us by M. Cornelius de Groot, for many years the chief mining director for the Dutch Government, and, I may add, a warm admirer, from grateful recollection of a visit long ago, of the mines and the people of Cornwall.

The island of Bangka was known from a very early time to produce tin. For some two centuries the metal had been made over, through the Sultan of Palembang, to the Dutch East India Company, in blocks of 10 kilos. in weight. Since 1816 it has been worked by the Dutch Government, the production being, in 1821, 1,250 tons, at 1,000 kilos. the ton; after twenty-five years, in 1846, it was above 4,400 tons; and in 1856 it attained its maximum of 6,250 tons. Since then it has decreased to a mean of 4,340 tons for the years 1871 to 1875, and to 3,932 tons for 1876, when the number of Chinese miners was 7,879.

De Groot considers the stratified rocks, the conglomerates, slates and grits, to belong to the lower part of the Devonian formation. The prominent crystalline masses are Granite; and the analogy to our Cornish tin-bearing rocks is thus so striking, that we look with anxiety to learn something of the geological features of other parts of this archipelago. The island of Blitong, formerly called Billiton, lying between Bangka and Borneo, was examined in 1850, and considered valueless for tin; but in 1851 a company was formed, and fresh explorations made, the results of which were, beginning with 11 tons of tin in 1853, a gradual increase to 3,721 tons in 1876. In April, 1877, the number of Chinese workpeople employed there was 3,856. The sedimentary rocks of Blitong also are stated to belong to the lower Devonian series (Graywacke), and in this island three distinct stanniferous lodes are said to exist; whilst in the Mangar district, in the east of the island, groups of strings and branches, "Stock-werke," have been met with, extremely rich in crystallized cassiterite, sometimes transparent and pale grey.

As a general rule the cover or overburden upon the stream tin

ground is, in Blitong, only about four or five yards in thickness, or half that of Bangka.

In the archipelago forming the residence or governmental district of Riow, south of Singapore, are, first, the isle of Karimon, where a very little tin ore is raised; Koundour, an islet where a trifle of cassiterite has been found; and the island of Singkèp, where the annual production, raised for the Sultan of Linga, is 30 to 40 tons of tin. Here, however, the mining engineer, J. H. Menten, has made trials on which he grounds a belief that workable tin is limited to one valley, that of Dabo.

On the eastern side of Sumatra Mr. Hedemann and a company have commenced, under a grant for seventy-five years from the Sultan of Siak, to work a stream deposit at Negri Tapong, and in September, 1877, had two hundred Chinese miners at work. It is stated that the geological features of this district are similar to those of Blitong, but opinions are divided as to its promise.

It is scarcely known to many of us how much the cheap and regular working of these extensive beds of tin-bearing alluvium has been advanced by systematic boring. In the Paris Exhibition a number of models, some of them made apparently by Chinese workmen, set before us very clearly their methods of carrying on this important industry.

The Chinese labourers seem in these tin-streams to be models of frugality; but what shall we say to the natives of parts of the interior of Java, where at several of the markets are sold biscuits made of dry clay, which is eaten without further cooking! At the Government coal-mine called Oranje-Nassau, the miners (convicts for twenty years or more) have been wont, of their own choice, to eat a clay obtained in the neighbourhood, and of which specimens were shown. Nos. 84, 93, and 106, were three varieties of these not very tempting cakes. De Groot says it was a clay impregnated with carbon, and that it was forbidden to the men from its having a bad effect on the eyes. Dr. Vlaanderen published in 1874 the analysis of an earth which he found the people eat in Humboldt's Bay in New Guinea, and which is a silicate of magnesia combined with oxide of iron and chromite. The coincidence of Humboldt's name coming in on these Eastern shores reminds

one of the statement of that illustrious observer, much doubted at first, but afterwards confirmed, of the Orinoco Indians, when food was scarce, eating certain clays. In the case of the American silicate eaters, it would appear to have been an ordinary aluminous clay, in that of New Guinea something more of the steatitic class. But whilst surprised to see the evidence of these vagaries among uncivilized peoples, we have to remember what a trade has existed nearer home, and is not yet extinct, in sundry insoluble aluminic silicate minerals, as notably the *terra sigillata* of Lemnos, the *bolus* of Armenia, and its twin-brother of Sinope. These, and some other allied substances, have, not exactly as food, but as medicines of an astringent and absorbent character, been largely, even in Europe and its confines, taken into the human interior.

I have ventured for the love of one of our indigenous metals, tin, to detain you for awhile in the far East. I would now invite you to a brief consideration of a district less remote, the history of which is intimately connected with our other prime metal—copper. We are all aware how the island of Cyprus is invested of late with a new interest for England. Amongst other subjects, that of its minerals, celebrated from the earliest times, has invited attention, and in more than one direction it has reached my ears that Cornish miners and inspecting agents are likely to proceed thither. Now it happens that, notwithstanding all the eulogies of ancient writers, Aristotle, Theophrastus, Strabo, Dioscorides, and Pliny, no real explorers since the old classical times, until very recently, have given us any clear account of the physical characters of the island. M. Albert Gaudry, an eminent figure in the scientific society of France, was the first to break the spell by publishing in 1862 the results of his detailed observations, accompanied by a geological map, which I exhibit.

As the book is not easily obtainable, and as I may illustrate his conclusions by what I have myself examined on the neighbouring coast of North Syria, I believe it may serve a useful purpose if I lay before you some guiding remarks founded on M. Gaudry's work. Between our northern countries and the southern and eastern lands which border on the Mediterranean there exists so strong a contrast in respect of certain prominent geological features,

and at the same time such differences are observable in the repositories of mineral, that a few hints may prevent misapprehension.

The island of Cyprus—in extreme length about 140 miles, or as far as from the Land's End to Taunton, by 30 to 40 miles wide—may be described rudely as a broad plain with a long narrow range of mountains bordering it on the north, and a wider and higher group of mountains on the south. A narrow strip of flat land also for the most part intervenes between the foot of the mountains and the sea. The principal towns are situate on low ground, and the flats where the rivers make their way to the sea, and cause an accumulation of stagnant water, give rise as usual in these latitudes to malaria fevers, much of the same character as those unfortunately so familiar to the residents in southern Spain, Italy, Sicily, Sardinia, and the Levant generally.

The Northern chain, called after the village of Cerines, or Kerinia, runs nearly east and west for some forty miles in length, and then bending north as it goes eastward, ends with a course of east, 30° north, in the singular narrow promontory, of nearly fifty miles long, called Carpas, which terminates with cape St. Andrea, and points to the mouth of the lovely valley of the Orontes, on the mainland, at a distance of eighty miles. In great part this ridge consists of jagged precipitous masses of compact limestone, presumed to be of that vast Cretaceous formation so utterly unlike the chalk series in our own country, but reminding the geologist of the grand accumulation of these rocks—the *scaglia* of some authors, which he encounters in Spain, in Dalmatia, Greece, and Turkey. The higher points attain an altitude of from two to three thousand feet, and their elevation is probably connected with certain igneous rocks (mostly pyroxenic wacke) which here and there rise up from below the calcareous strata. On both sides of the ridge, a series of distinctly stratified rocks, probably Lower Tertiary, Eocene, often sandstones like the *macigno* of the Italian and French authors, appear to have been displaced and uplifted. Then upon these there rest, in the great plain of Nicosia, the white marls ascribed to the Miocene division of the Tertiary; and in the Carpas the still higher group of yellow sands and coarse limestone (calcaire grossier), which from their fossils are concluded to be Pliocene.

Very different is the Southern mountain group, the Olympus; more rounded in outline, rising to altitudes of five and six thousand feet,* and composed so largely of igneous or crystalline rock, that nearly one-fourth of the area of the island may be computed to be formed of this material. The course of the chief axis of this range is parallel to the western part of the chain of the Cerines, and against its flanks are also to be found tracts of the Cretaceous limestone, of *Macigno*, and of the Miocene white marl which appears in some places to have been disturbed by the same agencies.

At the western extremity, and ending in Cape Epiphane (the ancient Cape Acamas), a short ridge of hills of less importance, the Acamantides, runs in the direction N.N.W. and S.S.E., and appears worthy of note from a resident Turk having given M. Gaudry specimens of chloritic schist from thence which may perhaps be of older date than the compact (probably Hippuritic) limestones, which were otherwise considered to be the oldest rocks of the island.

The dominant masses of the Olympus group, especially the summit of mount Tröodos, consist of serpentines, in which M. Damour has by analysis discovered the presence of nickel. This however must not be confounded with the occurrence of nickel ores in workable quantity. The serpentines pass through the intermediate stage of "Eupholite," to the *Granitone* of the Italian quarrymen, the Crousa-Down stone of the Lizard, to which the name of gabbro is commonly given, consisting of saussurite and diallage. Another great division consists of various aphanites, wackes, and other, frequently much decomposed, igneous rocks, classed by Gaudry as ophitic. These have a double interest for us, in producing by their decomposition strange forms and colours, as especially between Mospiloti and Visatchia, and secondly in exhibiting traces of metallic mineral. Thus specular iron was collected at Lisso, at Lithrodonta, at Hai Héracliti, and Stavro Vouni, or St. Cross; limonite at numerous localites; iron pyrites and vitriol at Dginhoussa; various ores of copper at the same place and at Lisso; peroxide of manganese at Visatchia and on

* The Tröodos is the culminating point, with a height of 6,582 feet, and notably mammillated in form, *Μαστοειδὴς Ὄλυμπος* of Strabo, lib. xiv. cap. c.

the side of Acoutzo. These substances occur near the outer boundaries of the rock masses, and particularly where decomposing action has been at work. Very often it is noticeable that jasper and other varieties of quartz accompany these chemical changes, and the metamorphic effect produced upon the adjoining strata of various ages is evidently a subject of high interest in many parts of the island.

But what confirmation have we of the vaunted metallic riches of Cyprus? We can have no doubt that the Greek word *Cupros*, the Latin *Cuprum*, the French *Cuivre*, the English *Copper*, German *Kupfer*, and Spanish *Cobre*, are derived from the name of the island where, according to old authors, it was first found and turned to account. A king Cinyras (Κινύρης), contemporary with Agamemnon, is mentioned by Homer, and stated by Pliny to have worked copper mines, and invented divers metallurgical contrivances. And there is no mistake about the identification of certain of the minerals described by Pliny as being raised at those mines, although with respect to some of them, where liberties have been taken with names, doubts may exist as to what was meant. Yet where are the traces of these works? M. Gaudry, besides his little stains and "faces" of malachite, azurite, and sulphide of copper, has little to point out except the vast heaps of slag, many of which he has indicated on the map, and of which he says that the dimensions are so far beyond the comprehension of the modern Cypriotes, that they have been wont to take them for volcanic craters. Many of these slags, taken from the Lithrodonta, Corno, Lisso, &c., were analysed in the laboratory of M. Fremy by M. Terreil. A somewhat unexpected result is, that with as usual a large percentage of protoxide of iron, there was from thirty to thirty-eight per cent. of sesquioxide of manganese, and a very small proportion, *i.e.* under one per cent., of oxide of copper. It would hence appear that whilst very large quantities of mineral have been treated, the ancient smelters had acquired great skill in their art. The statements of the occurrence of gold and of silver ores rest, like Pliny's account of the marvellous emeralds found in the same copper mines, upon very slender data, and sometimes upon erroneous observation.

There can in fact be little doubt that there is in Cyprus, if an uncertain, a very interesting region for mineral research. But we must be prepared to find the ores under a very different guise from that of the Cornish lodes. The Cerinian limestones first adverted to are probably the same strata which yield the abounding ores of zinc and lead so notable in the north of Spain and the island of Sardinia, as well as the wondrous iron ore deposits of Bilbao. Looking across the narrow sea to the coast of North Syria, you may trace a continuation of the same and the upper-lying formations in the white marl, associated with splendent masses of crystalline gypsum; and in the mountains between Latakieh and Iskenderoon, about Djebel Okrab, and north of the rich valley of Suedieh, you have the same massive limestones, with serpentine making its appearance here and there, commonly at their base. Of the picturesque beauty, the delicious climate, and the varied garden produce of this charming region, particularly between Antioch and the mouth of the Orontes, I cannot trust myself to begin to speak. A little further North, at Arghaneh, on the Tigris, the serpentine bears huge masses of pyrites and other ores of copper, giving rise to mines and smelting works that have been active for generations.* The strike or direction of these ranges, which from Cyprus points into the Pashalik of Aleppo, and the very similar alignment of parts of the Taurus chain, suggests such comparisons, and much weight is added to them when we throw into the scale the character of the rocks. Miners and geologists who have seen or studied the Cupriferous localities so renowned in the serpentine of Tuscany, will remember the strange impregnations and bizarre forms of deposit in varieties of this rock, the feeble appearance at surface, and the deeper-seated wealth of the purest ores in the mine of Monte Catini,† and will draw from inspection their own inferences as to the probability of awakening with advantage branches of industry that have slept for thousands of years.

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* Reference may be given to my description, quoted by M. Gaudry, of this district in *Quarterly Journal Geological Society*, vol. i.

† See the writings of Savi, Meneghini, and Burat in *Géologie Appliquée*, chap vii.

Of one thing we may feel assured, that in the great intercalated masses of crystalline gypsum, and in the fine building materials of the older, as well as the more recent limestones (the *scaglia* and the *calcaire grossier*), there are present the material aids to many improvements. The search for metallic minerals needing more intelligence and involving more uncertain results, will anyhow, if properly conducted, be the means of increasing knowledge, and of furthering, to the advantage of the native populations, the influence of this country in the East.

REPORT OF THE COUNCIL.

THE Council present to the Members this the Sixty-fifth Annual Report, and refer with great satisfaction to the history of the Society during the past twelve months.

Thanks to the cordial co-operation and friendly aid of Mr. Etheridge, the Museum has been enriched by a complete typical collection of British Fossils, thus realizing a long-felt want; and the collection—valuable in itself—is rendered doubly valuable by the skill and labour of Mr. Etheridge, who devoted a fortnight to its arrangement in the case appropriated to the purpose which has been purchased since the last meeting.

Mr. Etheridge has also been good enough to write an interesting letter on the subject.

In recognition of the interest he has taken in, and the great assistance he has rendered to, the Society, the Council beg to recommend the election of Mr. Etheridge as an Honorary Member. The Council have to regret the loss of Sir R. Griffiths, at an advanced age, of Dr. Oldham, Director-General of the Geological Survey of India, from amongst your Honorary Members; from the list of Ordinary Members of Mr. Charles Fox, your former President, whose learning so often instructed, and whose eloquence so often charmed you; of Sir F. M. Williams, cut off in the prime of life, and in the full tide of his usefulness; and of Captain Joseph Vea[illegible]ying full of years and honours, and long regarded as a representative type of the Cornish Miner.

Annual Report for the past year, and the Transactions of [illegible] have been for some time in the hands

The Librarian, in addition to his usual Report, records the valuable addition to the contents of the Library due to the kindness of the Rev. Edward St. Aubyn, and asks for a grant of £10 to purchase works, the want of which is much felt, and to continue the work of binding the pamphlets, &c.

The Treasurer's Account shows an unusually large expenditure, a considerable portion of which is caused by the addition to the Fossil Museum before referred to.

Considerable success continues to attend the instruction in Physical Science, given under the auspices of the Society, and the Council venture to hope that permanent good effects may be derived therefrom. The result of the examination shows that in Organic Chemistry two passed in the First, and one in the Second Advanced Class; seven passed in the First, and two in the Second Elementary Class. In Practical Chemistry: Three passed in the First Advanced Class; eight passed in the First and Second Elementary Class. In Mineralogy: One passed in the Second Advanced Class; two passed in the Second Elementary Class. In Geology: Four passed in the Second Elementary Class.

The Museum continues to be an object of interest to the many visitors to West Cornwall; and the book kept for that purpose records the names of nearly one thousand people.

Mr. Collins has published his interesting addition to the history of Cornish natural products—towards the cost of publication this Society has subscribed £10; he has also undertaken to carry out for the year a portion of the Instruction hitherto given by Mr. Barnett, and has submitted to the Council a proposal for a short course of Lectures on Geology during the months of December and January, of which the Council cordially approves.

WILLIAM BOLITHO, JUN., *pro Secretary.*

PENZANCE, *November 1st, 1878.*

LIBRARIAN'S REPORT.

AUTHORS' PRESENTATIONS.

Royal Asiatic Society. Notes and Recollections on Tea Cultivation in Kumaon. By J. H. Batten, F.R.G.S.

Mines and Mineral Statistics of New South Wales. By Professor Liversidge.

Notes on Boulders in South Devon. By W. Pengelly.

Address to the Geological Section of the British Association, August 16th, 1877. By W. Pengelly.

Notes on the Recent Notices of the Geology and Palæontology of Devonshire. (Part iv.) By W. Pengelly.

Notice pour la Classe 43 de l'Exposition Universelle de Paris, 1878. By Corns. de Groot.

The Hensbarrow Granite District. By J. H. Collins.

OTHER PRESENTATIONS.

The Geology of Wisconsin (Report). Vol. ii. 1873–77. From T. C. Chamberlain, Beloit, Wis.

United States Geological Survey of the Territories.

(*a*) Vol. ii. Monographs of North American Rodentia.

(*b*) Illustrations of Cretaceous and Tertiary Plants.

(*c*) Fur-bearing Animals.

(*d*) Bulletin of the Geological and Geographical Survey. Vol. iii. No. 4.

(*e*) Bulletin of the Geological and Geographical Survey. Vol. iv. No. 1.

(*f*) Descriptive Catalogue of Photographs of North American Indians.

(*g*) Ninth Annual Report of Progress for year 1875. All these from F. V. Hayden, U.S. Geologist.

Progress and Resources of New South Wales.

Mineral Statistics for Victoria for 1877.

Climate of New South Wales. By H. C. Russell. From the Royal Society of New South Wales.

Geological Survey of Victoria. (4 vols.)

Bulletin of the United States Survey, and vol. vii. on Tertiary Flora. From F. V. Hayden, U.S. Geologist.

Catalogue of the Library of the Museum of Practical Geology. Presented to the Society on behalf of Her Majesty's Government.

The following Maps presented by F. V. Hayden, Esq.:

1. Map of Upper Geyser Basin on the Upper Maddison River, Montana Territory.
2. Map of Lower Geyser Basin on the Upper Maddison River, Montana Territory.
3. Map of Sources of Snake River.

REPORTS.

THE following Reports, Transactions, Proceedings, Magazines, &c., have also been received:

Annales des Mines.

The London, Edinburgh, and Dublin Philosophical Magazine.

Proceedings of the Royal Society.

Journal of the Royal Institution of Cornwall (No. 19).

Reports of the Mining Surveyors and Registrars, Victoria.

Proceedings of the Mining Institute of Cornwall:

2. On the "Barrow" Rock Drill, and on Stamp Machinery.
3. On Dressing Tin Ores: on the use of Stone Breakers, and on Jigging Machinery.

Annual Report (Seventh) and President's Valedictory Address of the Leeds Naturalists' Club and Scientific Association, 1876–77.

Die Dorpater Naturforscher-Gesellschaft.

Sitzungsberichte der Dorpater Naturforscher-Gesellschaft.

IV. Band, Heft I.

Archiv für die Naturkude Liv-Ehst-und Kurlands.

I. Serie, Band.
II. Serie, Band V.
Proceedings of the Geologists' Association, and Report.
Annales de la Société Géologique de Belgique.
Transactions of the Edinburgh Geological Society.
Journal of the Geological Society.
List of the Geological Society.
Proceedings of the Royal Society of Edinburgh.
Transactions of the Manchester Geological Society.
Atti della Società Toscana di Scienze Naturali.
Proceedings of the American Academy.
Proceedings of the American Philosophical Society.
List of Members of the American Philosophical Society.
Annual Report of the Smithsonian Institution.
Palæontographical Society. (Vol. xxxii.)
Proceedings of the Bristol Naturalists' Society.
Proceedings of the Royal Society of New South Wales.
Report of the Royal Cornwall Polytechnic Society.
Proceedings of the Literary and Philosophical Society of Liverpool.
Report of the Leicester Town Museum.
Report of the Royal Institution of Cornwall, and Journal.
Preliminary Report of the United States Geological and Geographical Survey.
Annales de la Société Géologique.
Report of the Miners' Association.
Report of the Società Toscana.
Annual Report of the Departments of New South Wales.
Annual Report of the Warwickshire Natural History and Archæological Society.
Geological Record for 1876.

CHARLES C. ROSS, *Librarian.*

PENZANCE, *November 1st*, 1878.

CURATOR'S REPORT.

MINERAL DEPARTMENT.

I am glad to report that the number of Donations is much greater than it was last year. The specimens that have been received are as follows:

NAME AND LOCALITY.	DONOR.
Bismuthite, Wheal Owles, St. Just	Richard Boyns.
Zinc blende (four specimens), Great Laxey Mine, Isle of Man	F. Reddicliffe.
Anglesite, Parys Mine, Anglesea	T. F. Evans.
Chiastolite, Bosworgey Mine, St. Erth	C. Le Neve Foster.
Lithomarge, Cook's Kitchen Mine, Camborne	John Reynolds.
Tetradymite, Clogau Mine, Dolgelly	W. W. Smyth.
Galena (crystallized), with Black Silurian Slate, Wye Valley Mine, Montgomeryshire	W. W. Smyth.
Spathose Iron, Brendon Hills Mines	H. Skewis.
Tourmaline-granite, Letcha, St. Just	Alfred Chenhalls.

The following specimens were all presented by Mr. W. H. Tulloh, of Sydney:

1. Iron Pyrites (Gold bearing), with Chalcopyrite and Blende, from Major's Creek, New South Wales.
2. Copper, Lead, Gold, and Silver, from Major's Creek, New South Wales.
3. Iron Pyrites (Gold bearing), Adelong, Tuncet, New South Wales, taken from a shaft at a depth of 820 feet.
4. Iron Pyrites and Blende, from Spring Creek, near Bungonia, New South Wales.
5. Iron Pyrites, containing Gold, from Major's Creek, New South Wales.
6. Copper Pyrites, Bungonia District, New South Wales.
7. Red Oxide and Black Oxide of Copper, from Southern Copper Mine, near Burrowa.

8. Carbonate and Red Oxide of Copper, from Southern Copper Mine, near Burrowa.
9. Red Oxide and Green Carbonate of Copper, from Southern Copper Mine, near Burrowa.
10. Blue Carbonate of Copper, with Gossan, New South Wales.
11. Copper Ore, from Cowflat, Bathurst District, New South Wales.
12. Azurite, from Woolgaro, New South Wales.
13. Cinnabar, in Dolomite and Carbonate of Lime, Kilkiven, Queensland.
14. Cinnabar, in Dolomite and Carbonate of Lime, Kilkiven, Queensland.
15. Arsenical Iron Pyrites (Mispickel), from the Bathurst District, New South Wales.
16. Ironstone, from Port Hacking, New South Wales.
17. Phosphate of Iron, from Mount Wyatt, New South Wales.
18. Semi-opal, from Listowel Downs, Queensland.
19. Opal, with Volcanic Lava, Queensland.
20. Chalcedony, from New Caledonia.
21. Chalcedony, from Two-mile-flat, New South Wales.
22. Garnet Rock, from New England.
23. Gold-bearing Conglomerate, with Azurite Crystals, from Winter's Claim, Mitchell's Creek, New South Wales.
24. Rolled Sand Ball, containing Mineral not yet examined, from the Merimbula District, New South Wales.
25. Silicified Wood, from Northern Queensland.
26. Lode Tin, Deep Sinker's Mine, New England, New South Wales.
27. Tin Wash Dirt, New England, New South Wales.
28. Lead Ore, containing Silver, from Yarrol Mine, near Gunnedate, New South Wales.
29. Quartz Crystal, from the Macintyre River, Queensland.
30. Shales, from Ioadga, New South Wales.
31. Pyrrhotite, Gondolph's Claim, Hill End, New South Wales, rich in Gold.
32. Antimonite, from Lionsville, Grafton District, New South Wales. found in Slate formation. Assay, 69·6 per cent.
33. Antimonite, from Wallerawang District, New South Wales, in Quartz formation. Assay, 42·53 per cent. in bulk.
34. Nickel Ore, from the Deux Branches Mines.
35. Nickel Ore, from Mont D'Or Mine, New Caledonia. Assay, 12 per cent.
36. Scented Gum, from New Guinea (derivation unknown).
37. Kauri Gum, Auckland, New Zealand.
38. Lode Tin, from the Deep Sinker's Mine in the Gulf, near Dividing Range of Colony extreme North, New England.
39. Iron Pyrites, Ravenswood Diggings, Northern Queensland.
40. Agate, from Agate Creek, Queensland.

41. Native Copper, and Cuprite, Dottswood Copper Mine, Plumtree Creek, Northern Queensland.
42. Native Copper, Cloncurrie Copper Mine, Northern Queensland.
43. Hematite, Gilbert River, Northern Queensland.
44. Quartz Crystals, in Chalcedony Geode, Agate Creek, Northern Queensland.
45. Gold-bearing Rock, Hill End, New South Wales.
46. Plumbago, Cape Upstart, Queensland.
47. Cobalt Ore, North-East Coast, New Caledonia.
48. Petrified Wood, New Zealand.
49. Limestone Rock, Port Jackson.
50. Lode Tin, Belmont Company's Mine, North-East Coast, Tasmania.
51. Chrome Iron Ore, New Caledonia.
52. Tin Crystals, from the Great Dividing Range, Queensland.
53. Lode Tin, Vegetable Creek, New South Wales.
54. Chrome Iron Ore, New Caledonia.
55. Lode Tin, Mica Schist, from Fly-by-night Mine, North-East Coast, Tasmania.
56. Wash Dirt, Aplin's Claim, Stanthorpe.
57. Wash Dirt, Little Wonder Claim, Vegetable Creek, New England.
58. Dragon's-blood Gum, New South Wales.
59. Grass-tree Gum, Botany Bay.
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With the sanction of the Council I have purchased eighteen specimens for the Museum, as follows:

NAME.	NO. OF SPECIMENS.	LOCALITY.
Calcite	1	North of England.
Cassiterite	2	Cornwall.
Cronstedtite	2	Wheal Jane, Truro.
Liskeardite	1	Marke Valley Mine.
Ludlamite	4	Wheal Jane, Truro.
Quartz and Chalybite	1	Pednandrea.
Scorodite	1	Marke Valley Mine.
Tourmaline-rock	1	Ding Dong Mine.
Vivianite	4	Wheal Jane, Truro.
Zincite and Franklinite	1	New Jersey, U.S.A.
Total	18	

FOSSIL DEPARTMENT.

It is in the Fossil-room that the greatest amount of work has been done this year. A new wall-case has been erected, and, thanks to the zeal and energy of Mr. Etheridge, it now contains

a typical collection of British Fossils, numbering upwards of a thousand specimens. To describe this collection and explain the manner in which it has been made, I cannot do better than quote Mr. Etheridge's own words:

"I now comply with your wish relative to the condition of the Geological portion of your Museum and its contents, to which has lately been added a series of characteristic fossils (chiefly invertebrata) for the use of students and others; the want of them was remarkable when compared with the fine and interesting collection or series of minerals arranged in your mineral-room, and almost unrivalled in the kingdom.

"Your President and Council authorised me last year to procure such a series of fossils or organic remains as would constitute a fairly typical collection illustrating the chief Geological (stratigraphical) formations of the British Islands. I have therefore obtained from various sources during the past year those species readily obtainable, and which fairly represent the distribution of invertebrate life through time; such indeed as will enable a student to understand most of the manuals on Geology. This series may be doubled or quadrupled, that being merely a question of space and outlay; as it now stands it is a gain to your museum, and an advantage to students.

I have arranged the fossils stratigraphically in descending order, and also, so far as can be done, zoologically. The lowest groups in each formation being placed first, or in structural order.*

"The Post Pliocene, Pliocene (Crag) and Eocene species occupy the uppermost shelf, and are arranged from right to left.

"The Cretaceous (Upper Chalk, Lower Chalk, and Greensand) are arranged on the second shelf, reading from left to right. The Gault and Cambridge Greensand (Gault in part), Neocomian, Wealden, and Purbeck occupy the third shelf.

"The Portland, Kimeridge Clay, Coral Rag, Oxford Clay, Kellaways Rock, Cornbrash and Great Oolite are placed upon the fourth shelf. The fifth is filled with the Inferior Oolite and part of the Upper Lias.

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* This of course is incomplete for the want of more materials.

"The upper shelves in the left hand and other cases at the base of the cabinet contain Middle and Lower Lias Mollusca, &c., and Coal Measure Plants; and the basement or floor shelves hold the Carboniferous Limestone, Middle Devonian, and Lower and Upper Silurian Fossils. No addition could be made to your already fine series of local Devonian Fossils, embracing species from all three divisions of that group of rocks.

"The specimens selected are as good as could be obtained, and are all characteristic of the strata in which they occur, and on the whole I believe and hope the Council will have reason to think I have been able to help them; and with Lyell's 'Student's Manual,' Jukes's 'Manual,' or Ramsay's 'Physical Geography and Geology of the British Isles,' the series may be rendered useful for students. I again went over the old wall-case collection, and endeavoured to place it in order. The three upper shelves however contain so heterogeneous a series, that little or nothing could be done with them stratigraphically.

NOTE ON THE DEVONIAN COLLECTION, &c., CONTAINED IN THE TABLE CASES.

"Nearly the entire collection or series of fossils in these five cases is Devonian—Lower, Middle, and Upper, the greater part of which was collected by Mr. C. W. Peach upwards of thirty years ago. No series of Devonian Fossils in Britain is equal to that now arranged in your Museum, or in possession and the property of the Royal Geological Society of Cornwall. The collection still requires much attention, owing to there being some unnamed and many new species. This part of the Society's collection should be taken in hand by some local member, and the series added to whenever possible, carefully compared and correlated with the Continential Devonians—Belgian, French, and Rhenish. Under any circumstance nothing should be left undone to secure and add to the already valuable series so long ago obtained by Mr. Peach, and still the finest in England.

"There are still two or three divisions or formations in your typical collection which I will add to when the opportunity occurs."

The Society is deeply indebted to Mr. Etheridge for his valuable labours, for he has enabled us at a comparatively small cost to become the possessors of a suite of specimens which is without rival in the West of England. Indeed I doubt whether another such representative series can be found anywhere west of Bristol.

It is most important that Mr. Etheridge's suggestions with regard to the proper arrangement of the Local Devonian Fossils should be attended to. I trust that, now the Society is in possession of such a typical series of minerals and fossils, it will appoint a paid Curator, whose business it will be to devote one or two days a week to the Museum. I greatly regret that the leisure at my disposal does not enable me to look after the collections properly, and it is only by securing the services of some well-qualified person who is ready to attend regularly that suitable catalogues can be prepared, and the Museum rendered as attractive and useful as it deserves to be.

CLEMENT LE NEVE FOSTER,
Honorary Curator.

PENZANCE, *Nov.* 1*st*, 1878.

TREASURER'S STATEMENT, 1877-78.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

RECEIPTS.

	£	s.	d.
To Balance	39	16	5
„ Donation H.R.H. The Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears	86	2	0
„ Interest on Deposit	6	6	2
„ Transferred from Deposit	10	0	0
„ Expenses connected with Prize Essay, repaid by Mr. Basset	2	13	1
	£164	17	8

EXPENDITURE.

	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper	3	5	0
„ Insurance	2	12	9
„ Expenses per Treasurer and Secretary	5	18	0
„ Subscriptions to Palæontographical Society	1	1	0
„ Printing, Stationery, &c.	22	8	3
„ Case for Fossils	36	0	0
„ Minerals and Collection of Typical Fossils	86	5	6
„ Sundry Bills	4	12	3
Balance forward	2	6	11
	£164	17	8

W. BOLITHO, JUN.,
Treasurer.

October 31st, 1878.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

NOVEMBER 1st, 1878.

1. On the Stratigraphy of West Cornwall. By J. H. Collins, F.G.S.

2. On a Rock resembling Luxullianite, from St. Just. By C. Le Neve Foster, D.Sc.

3. On Balleswidden Mine. By Capt. T. P. Rowe and C. Le Neve Foster, D.Sc.

4. On the Rock Salt and Carnallite Deposits of Stassfurt and Neighbourhood, near Magdeburg. By Joseph Garland.

PRELIMINARY NOTE

ON THE STRATIGRAPHY OF WEST CORNWALL,

By J. H. Collins, F.G.S.

Read November 1st, 1878.

The Geological Map of Cornwall shews a small patch of Silurian rocks, extending from Gerrans Bay to Gorran Haven; all the rest of the stratified rocks, eastward and westward, being marked as Devonian.

I have been for a long time convinced, that the rocks to the south of Truro are not Devonian; and during the last two years I have spent a good deal of time, in company with Mr. T. Clark, of Truro, in investigating the structure of that portion of the county which is included between lines drawn from Par to Newquay, and from Falmouth to St. Agnes.*

On referring to Sir Henry De la Beche's classical "Report," we found very little reference to the district in question, and especially to that portion of it which has proved to be the key to the whole, viz., the parish of Ladock; consequently, we have had to deal with what was, to a great extent, an unworked field.

In working this out, we have had to contend with the following difficulties—

* This district includes the greater part of the Hensbarrow granite, which I have fully described in a recently published pamphlet.

1. General similarity of mineral character in the rocks.

2. Numerous disturbances by faults and dislocations.

3. Frequent obliterations, or at least maskings, of stratification by cleavage.

4. Numerous overturns of the strata near the outcrops.

5. Absence of fossils, except at the extreme south and extreme north, where alone limestones are known.

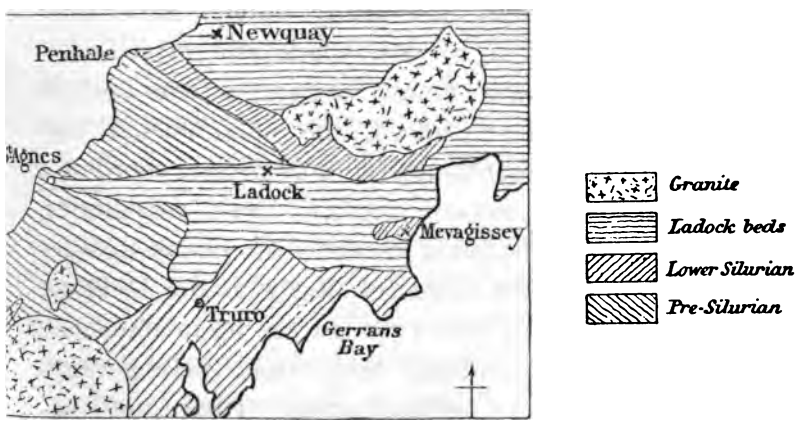
As I have said, the key to the whole district was found in the parish of Ladock—in beds of still uncertain age—which I propose to refer to as the Ladock beds, but which I believe to be Upper Silurian.

These Ladock beds consist of alternations of gray schistose strata, at times almost like roofing slate, with others which are of a softer character, and red or yellowish, together with a few thick beds of fine or coarse-grained sandstones, or conglomerates, which contain besides rounded pebbles some sharply angular fragments of dark slate.

The Ladock beds have a remarkably regular east and west strike, and they are rolled over and crumpled together, so as to form at least two troughs and three saddles; these are seen, best of all, in the Ladock valley.

After a good deal of labour, and with valuable assistance from Mr. Clark, I have, I think, succeeded in determining approximately the boundary of the area covered by these rocks, as marked on the

accompanying map, which also shews the areas where the underlying rocks reach the surface.



As to the age of the Ladock beds, I can only say that they appear to me to be distinctly older than the Devonian beds of the eastern part of the county, and that I think they will prove to be Upper Silurian.

Fossils have been found in these beds, in bands of limestone, and also more sparingly in the slate, at Newquay, and at the Van, south of St. Austell; but as yet very few of these have been specifically determined.* They consist chiefly of fragments of encrinites, trilobites, spirifers, and corals. Only two inland localities have ever been noted as fossiliferous within the area covered by these beds, viz., at Poltesco, near Truro, where Mr. Peach found some apparently organic remains many years ago,† and at Wheal Hope, in Perranzabuloe, from which locality Mr. W. Mansell

* The Museum of the Royal Geological Society of Cornwall contains fossils from both these localities, chiefly encrinites, corals, and fragmentary trilobites.

† "Trans R. G. Soc. Corn." vol. vi. p. 181.

Tweedy believed he obtained some encrinital stems, also many years ago.*

These localities, and many others, have been patiently searched by Mr. Clark and myself, but hitherto we have found nothing of undoubted organic character; indeed, the obscure markings which we have found, appear to us to have more of a mineral than an organic origin.† In the sandstones, however, we have found certain ferruginous nodules occurring in lines corresponding with the bedding, and these contain from a mere trace up to about one per cent. of phosphoric acid, which may perhaps be derived from an organic source. I have not however, been able to detect any trace of organic structure in any of them.‡

The Ladock beds rest unconformably upon a series of rocks—chiefly gray slaty beds—having a N.E. and S.W. strike. The only distinctly fragmentary rocks which we have been able to discover in this series occur in the upper portion, viz., at Gerrans Bay, where we have the trappean conglomerate of the Nare Head described by Sir H. De la Beche,§ and a thick sandy bed a little to the westward, and underlying the great bed of quartzyte which forms so marked a feature of the landscape at its outcrop, from the village of Carne, to near Gorran.

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* "Rep. Roy. Inst. Corn."

† Since this was written my son (*aet.* 14) has found what appears to be a metamorphosed coral (? Favosites), at Lower Newham, near Truro.

‡ At Treworgans Quarry, in the parish of Probus, certain cavities in the sandstone beds contain many beautiful little crystals of Aragonite—usually a very rare mineral in Cornwall.

§ Report, &c., p. 84.

This great series of beds was, long ago, shewn to be of Lower Silurian age, by the fossils discovered by Mr. C. W. Peach, which now form part of the collections of the Royal Geological Society, and of the Royal Institution of Cornwall. Among them are several species of orthis, and two or more trilobites, which seem to shew that the quartzyte is of Caradoc or Upper Llandovery age.

Several thin irregular beds of limestone occur at Gerrans Bay, as is well known,* but hitherto they have been thought unfossiliferous. Mr. Clark and myself, however, have found in them numerous fragments of some small species of encrinite, and, I believe, of other organisms also.

Most of the beds however, are schistose, and have yielded as yet no fossils.†

The unconformability of the Ladock beds upon these Lower Silurian rocks can be seen very well on the coast, a little to the south of Pentewan, and again at Chapel Point, near Mevagissey; besides which it is evident enough at several places near Truro, although the actual overlies are obscured.

These Lower Silurian rocks, on the whole, dip mainly to the S.E., but there is at least one saddle and trough, indicating compression at right angles to

* These limestones were noticed by the Rev. J. Trist, and the Rev. Canon Rogers, "Trans. R. G. Soc. Corn." vol. i. p. 107.

† In the schistose beds at Gerrans Bay, which are often nearly black, Mr. Clark and myself found recently a mineral vein, containing pale pink calcite, in cavities of which were beautiful hair-like crystals of Millerite, one of the rarest Cornish minerals. A specimen from this locality is placed in the Museum of the Royal Institution of Cornwall. A *rounded* and *fractured* pebble of iron pyrites was found embedded in these dark schistose beds.

the strike previously to the deposition of the Ladock beds.

At dead low water on the coast to the S.W. of Pentewan, several outcrops of still older rocks having a strike nearly at right angles to the Lower Silurians of Gerrans Bay may be seen. These rocks appear again from beneath the Lower Silurians in the East Wheal Rose Valley, and on the coast at Penhale Point, between Perranporth and Holywell Bay. In these rocks, up to the present time, neither sandstones nor limestones are known, nor have any fossils been found; they are however, greatly crumpled and thrown up at high and frequently reversed angles, in a band crossing the country from Penhale to Pentewan, and I should be disposed to regard them as of Cambrian, or at least, of Pre-Silurian age.

They seem to extend westward, so as to include the whole of the Redruth, Camborne, and Illogan Mining Districts, and the celebrated East Wheal Rose and West Chiverton Mine are also situated in these beds.

I hope, during the next twelvemonth, to investigate these rocks more minutely; but I would now briefly draw attention to certain general ideas which have forced themselves on my mind, while studying this apparently unattractive, but really most interesting area.

1. A great lapse of time is indicated between the deposition of these three great series of rocks—time long enough for the great lines of pressure in the earth's crust to change their direction—first,

nearly 90°, and then again about 45°. Time also to allow of the production of planes of denudation after such crumplings, and before the next series of depositions.

2. The elvans, faults, and mineral lodes cross all three formations alike; consequently, they are newer than the Ladock beds.

3. The granite has been extruded through these greatly compressed and contorted rocks, without in any way disturbing them, the various strata abutting up against the granite directly in numbers of places, as for instance at Cligga Head and at Carclaze Downs. At the same time, however, the granite has penetrated the stratified rocks in the form of veins in a great many places, and these rocks are usually altered into tourmaline schist, at and near the junctions.

ON A ROCK RESEMBLING LUXULLIANITE,

FROM ST. JUST;

AND ON SOME GLOBULAR MASSES OF SCHORL-ROCK FROM DING DONG MINE.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

The rock known as Luxullianite consists of large pinkish crystals of orthoclase, imbedded in a groundmass of schorl and quartz. It is what the Germans have called *tourmaline granite*. It was minutely described last year by the Rev. T. G. Bonney (*Mineralogical Magazine*, vol. i. p. 15), who regards it as an altered granite.

I have lately found specimens of a somewhat similar rock, not *in situ* unfortunately, but as blocks scattered on the surface, near Letcha farm, about a mile S.W. from St. Just. The component minerals, however, do not exist in the same proportions as in the Luxullian specimen. In these orthoclase predominates; whereas in the St. Just rock the white or brownish-white orthoclase crystals, lie comparatively sparsely interspersed in the groundmass, which is a granular mixture of quartz and schorl. Closer examination reveals orthoclase crystals in all stages of decomposition. Some exhibit a few spots of schorl,

whilst in others the original mineral is almost entirely gone, and its place more or less completely filled up by schorl and quartz. We meet with many cavities shaped like felspar crystals, and lined with crystals of quartz and schorl, and finally there are the complete pseudomorphs of these minerals after the felspar.

For my own part, I have no hesitation in calling this rock an altered granite. It appears to me to be a transition, or passage rock, between true granite and true schorl rock. I believe if we could meet with a section of it *in situ* that the evidence of the passage would be very clear.

The globular masses of schorl rock found in Ding Dong mine are somewhat curious, and deserve a passing notice.

In clearing out a level where the soft granite had burst in shortly after it had been driven, numerous more or less round lumps of schorl-rock were discovered lying loose. They are from an inch to four or five inches in diameter, with a rough surface. They appear to consist simply of quartz, schorl, and a little kaolin; and one specimen exhibits kaolin apparently pseudomorphous after orthoclase. No doubt, as in nearly every other instance, this schorl-rock has been formed by the alteration of granite; but it is curious that the metamorphic action gave rise to these forms.

OBSERVATIONS ON BALLESWIDDEN MINE.

By Capt. T. P. Rowe and Dr. C. Le Neve Foster.*

The object of this paper is to give a short description of a tin-mine which was abandoned in 1873. We think it advisable to make a record of the facts in our possession, for fear that many interesting details may be forgotten or remain unknown.†

Balleswidden mine lies about a mile E. by S. from the village of St. Just-in-Penwith. It is wholly in granite, and differs from most of the other mines in the parish by being a considerable distance, two miles in fact, from the slate. The principal lodes that were worked were known respectively as Awboy's, the New, and the South lodes, and some tin was obtained also from the two Pie lodes. We shall also have to notice several *cross-courses* and *slides*, besides the so-called *Spar lode* and *Clay-course*. Fig. 1 gives a general idea of the run of the lodes.

* The principal facts contained in this paper were collected by Capt. T. P. Rowe, who was formerly one of the agents of the mine. My part has consisted in putting these facts together, and adding some particulars derived from personal inspection of the underground workings shortly before the mine was stopped.—C. L. N. F.

† Mr. W. J. Henwood devotes a page to this mine (*Trans. Roy. Geol. Soc. Cornwall*, vol. v. p. 15); but his description is not illustrated by a figure, and consequently does not convey a very exact idea of the manner in which the tin ore occurs.

AWBOY'S LODE.—In the southern part of the mine the bearing of this lode is about N. 42° W. (true) for more than a quarter of a mile; on going northwards it turns 10° more to the W. The dip is S.W., varying from 75° at the S.E. part to 60° at the N.W. extremity of the workings (*underlie* 18 inches to 3 feet in a fathom). The structure of this lode deserves particular attention; the so-called lode consists of four or five small parallel tin veins, bounded on each side by a hard rock, locally known as *hard-work*, which merges into granite. The total width of the lode varied from 10 to 20 feet, and averaged about 12 feet. Each little vein or *leader*, known at Balleswidden as a *gry*, was generally about a half-inch thick, and rarely widened out to more than 4 inches. The *gries* rarely united with one another along the dip or the strike, but often dwindled away to a mere string or joint. The filling-up of these little veins consisted of coarsely crystallized tinstone, with schorl, quartz, gilbertite, and kaolin (*prian*); a little wolfram, fluor spar, bismuthine,* and native copper were also sometimes met with. The little veins or *gries* were continually varying in productiveness; as a rule only one of them was rich in any given section, and as soon as it began to dwindle away one of the neighbouring ones began to improve. There was always a sharp and well-defined *wall* between the *gry* and the adjoining *hard-work;* and this was of importance to the miner, as it enabled him to separate the rich *gry* from the poorer rock adjoining it, and make a

* HENWOOD. *Op. cit.*

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By Capt. T. P. Rowe and Dr. C. Le Neve Foster.*

The object of this paper is to give a short description of a tin-mine which was abandoned in 1873. We think it advisable to make a record of the facts in our possession, for fear that many interesting details may be forgotten or remain unknown.†

Balleswidden mine lies about a mile E. by S. from the village of St. Just-in-Penwith. It is wholly in granite, and differs from most of the other mines in the parish by being a considerable distance, two miles in fact, from the slate. The principal lodes that were worked were known respectively as Awboy's, the New, and the South lodes, and some tin was obtained also from the two Pie lodes. We shall also have to notice several *cross-courses* and *slides*, besides the so-called *Spar lode* and *Clay-course*. Fig. 1 gives a general idea of the run of the lodes.

* The principal facts contained in this paper were collected by Capt. T. P. Rowe, who was formerly one of the agents of the mine. My part has consisted in putting these facts together, and adding some particulars derived from personal inspection of the underground workings shortly before the mine was stopped.—C. L. N. F.

† Mr. W. J. Henwood devotes a page to this mine (*Trans. Roy. Geol. Soc. Cornwall*, vol. v. p. 15); but his description is not illustrated by a figure, and consequently does not convey a very exact idea of the manner in which the tin ore occurs.

AWBOY'S LODE.—In the southern part of the mine the bearing of this lode is about N. 42° W. (true) for more than a quarter of a mile; on going northwards it turns 10° more to the W. The dip is S.W., varying from 75° at the S.E. part to 60° at the N.W. extremity of the workings (*underlie* 18 inches to 3 feet in a fathom). The structure of this lode deserves particular attention; the so-called lode consists of four or five small parallel tin veins, bounded on each side by a hard rock, locally known as *hard-work*, which merges into granite. The total width of the lode varied from 10 to 20 feet, and averaged about 12 feet. Each little vein or *leader*, known at Balleswidden as a *gry*, was generally about a half-inch thick, and rarely widened out to more than 4 inches. The *gries* rarely united with one another along the dip or the strike, but often dwindled away to a mere string or joint. The filling-up of these little veins consisted of coarsely crystallized tinstone, with schorl, quartz, gilbertite, and kaolin (*prian*); a little wolfram, fluor spar, bismuthine,* and native copper were also sometimes met with. The little veins or *gries* were continually varying in productiveness; as a rule only one of them was rich in any given section, and as soon as it began to dwindle away one of the neighbouring ones began to improve. There was always a sharp and well-defined *wall* between the *gry* and the adjoining *hard-work;* and this was of importance to the miner, as it enabled him to separate the rich *gry* from the poorer rock adjoining it, and make a

* HENWOOD. *Op. cit.*

little parcel of *best work*. The greater part of the tin was contained in the *gries*.

The *hard-work* on each side, from two to six inches wide, is a granular mixture of quartz, schorl, and gilbertite, with a little mica, fluor spar, and tinstone. The tinstone is almost always very finely disseminated through it. Occasionally pseudomorphs of quartz and of gilbertite after orthoclase were observed in the *hard-work*, and coarsely crystallized tinstone has also been found filling up cavities left by the removal of the same mineral. There was never any *wall* or sharp plane of division between the *hard-work* and the granite. The portions of this rock lying between the bands of *hard-work* were often soft and decomposed in the middle, forming what the Balleswidden miners called *gook*. The granite usually presented large and well-developed crystals of orthoclase.

Figure 2 shows the general appearance of the lode. A B C D E are *gries* bounded on each side by *hard-work*, and G G G G, &c., are the intervening bands of granite, either decomposed for their entire width or only in the central part. G′ is the granite on the sides of the lode.

At the S.E. part of the mine the workings were shallow, and the lode was productive in some places up to the surface. The enclosing granite was soft; but when it became hard in depth the lode fell off in productiveness. Proceeding to the N.W. the lode continued to be rich to a greater and greater depth; and although the granite was hard it was much jointed, which was a favourable sign in Balleswidden.

Fig. 1. (PLAN)

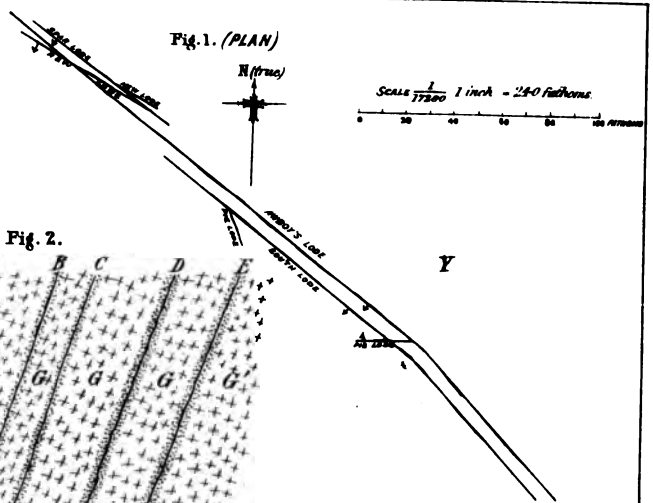


Fig. 2.

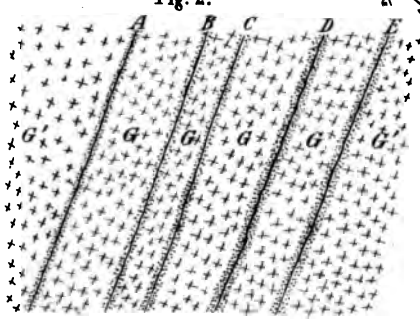


Fig. 3.

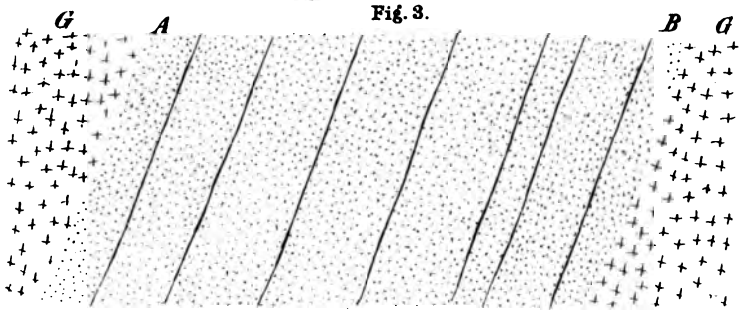


Fig. 4.

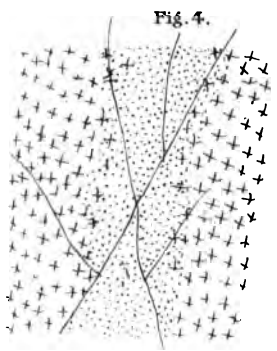


Fig. 5.

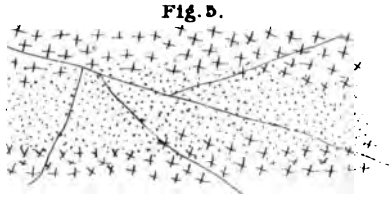


Fig. 6.

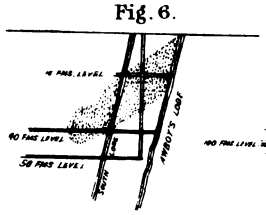
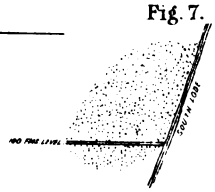


Fig. 7.



SCALE of FIGS. 2, 3, 4, 6.
1/96 1/8 inch = 1 Foot.
0 2 4 6 8 10 FEET.

SCALE of FIGS. 6 & 7.
1/3760 1 inch = 140 Fathoms.
0 20 40 60 Fathoms.

W. Brendon & Son, Lith. Plymouth

Before reaching the clay-course the granite became soft and clayey, and the lode preserved its productiveness from the surface to a depth of 60, 70, or even 90 fathoms. As a rule, in the granite surrounding good tin ground the orthoclase crystals had a dull, earthy appearance, whilst in the underlying unfavourable granite they possessed the vitreous lustre which belongs to the unaltered mineral.

The greater the dip of Awboy's lode the more likely it was to be productive. On meeting with the New lode the dip was reduced to 70°, and the value fell off, save at the very intersection, which was rich; and further to the N.W., where the dip was reduced to 60°, Awboy's lode was very poor.

South Lode. — This lode lies about 18 to 20 fathoms S.W. of Awboy's lode, to which it is parallel, and which it so closely resembles in character that no special description need be given of it.

New Lode.—The New lode runs rather more to the west of north than Awboy's lode, which it crosses near the N.W. extremity of the workings. It resembles the two previous lodes in character, though in the part near the spar lode the granite disappeared entirely, and the lode became a mass of *hard-work* 24 feet wide, traversed by numerous *gries* as shown in figure 3. Further N.W. the *gries* contained less tin and more mispickel, wolfram and copper; and one *gry* was seen for a length of several fathoms, averaging about 3 inches wide, and consisting of 90 per cent. of mispickel, with some fluor spar and coarsely crystallized tinstone.

PIE LODES.—The name *pie* was used at Balleswidden to denote a rock composed mainly of quartz, gilbertite, schorl, and cassiterite, often slightly cellular. There were two special *pie* lodes. One ran about E. and W. and dipped north about 80°. It started off from Awboy's lode and crossed the south lode. The other *pie* lode went off from the south lode, with a bearing of about S. 20° E., and was nearly vertical. A cross-section of one of these *pie* lodes would be much as shown in fig. 4, whilst fig. 5 gives the horizontal section where numerous joints are seen running into the *pie*. Figure 6 is a longitudinal section of the southern *pie* lode; the stippled part shows the extent of the ground worked away for tin. Figure 7 is a longitudinal section of the other *pie* lode.

Both the *pie* lodes were offshoots, as it were, of the main lodes, and resembled in this way the *carbonas* of the St. Ives district; they usually gave out a good deal of water at their junction with the main lodes, and this is an additional point of similarity. They differed however in composition; for whereas the rich St. Ives *carbonas* consisted in the main of stanniferous schorl-rock, the productiveness of the *pie* lodes decreased if schorl predominated over the gilbertite. The usual thickness of the *pie* lodes was about 3 feet, but they increased to 6 feet occasionally, and then dwindled away all round the productive part to a mere string.

CROSS-COURSES.—The mine was traversed by several cross-courses, which did not vary much in character.

They were veins of quartz, about 1 foot wide, with red clay, and occasionally a little specular iron. Their general course was about E. 40° N., and they dipped N.W. about 70°. They contained no tin, but were of use to the miner in affording easier ground for cross-cuts.

SLIDES.—The slides were numerous; their bearing and dip was generally much the same as that of the cross-courses. They were veins of red clay, about 6 inches wide, presenting very marked striations or slickensides, apparently produced by a rubbing action. The heaves produced by the cross-courses and the slides were generally to the right hand, but small in amount.

SPAR LODE.—This was a vein of quartz, about 12 feet wide, containing a large number of *horses* of granite of all sizes, running about N. 56° W., and dipping S.W. It was not tin-bearing: it heaved the New lode very strongly to the left.

CLAY-COURSE.—This was a channel of decomposed granite, 60 feet wide, with irregular veins of quartz, running about N. 12° W., and dipping W.

Having described the lodes it remains for us to say a few words concerning their probable mode of origin.

The little veins or *gries* evidently occupy spaces left by cracks or fissures, which were no doubt originally formed in clean granite. The open cracks were then probably filled up from below by solutions which caused the deposition of the tinstone and other minerals; and we are of opinion that the same in-

fluences which brought about the filling-up of the small veins changed the granite on each side into the *hard-work* which we now find. The theory of the *hard-work* being merely altered granite receives considerable corroboration from the fact of our finding pseudomorphs of tinstone, quartz, and gilbertite, after orthoclase, in this rock bounding the veins, and from there being no distinct line of separation between this rock and the granite. The case is similar to that of Cligga and St. Michael's Mount. The *gook* appears to be granite where the decomposing action produced by fluids brought up by the veins has not gone so far, where the orthoclase has simply been converted into kaolin; but there is this difficulty, that there is often hard granite between the *gook* and the *hard-work*, and why this should have escaped decomposition is not very apparent.

We must here remark that the word *lode*, as used by the Balleswidden miners, did not denote the mere contents of a fissure, but was applied to the whole band of granite containing the little tin veins and their crusts of *hard-work*.

The *pie* lodes are probably altered granite, where, owing to some slightly different chemical action, there has been a larger amount of gilbertite formed from the orthoclase.

The *tinstuff* obtained from the mine, that is to say the *gries*, together with the adjacent *hard-work*, produced about 60 lbs. of *black tin* to the ton of stuff, or rather more than 2½ per cent. Mr. Edmund Davy, formerly the purser of the mine, has kindly furnished

us with the following statement of the amount of tin sold during the last adventure:

Period.	Quantity of *black tin*.	Value.
	tons. cwts. qrs. lbs.	£ s. d.
February, 1837, to October, 1838	quantities not entered.	8,995 10 2
November, 1838, to April, 1873	11,828 0 0 9	685,098 13 7
		694,094 3 9

As the quantity sold during the first eighteen months' working could not have been less than 200 tons, we may say that during the 36 years that the adventure lasted, more than 12,000 tons of black tin were sold, of a value of £694,094.

ON THE ROCK-SALT AND CARNALLITE DEPOSITS OF STASSFURT AND NEIGHBOURHOOD,

NEAR MAGDEBURG.

By Joseph Garland, F.G.S.

Stassfurt was noted for more than a thousand years for its saline springs, the extraction of the salt from which gave employment to a portion of a scanty population, the remainder of whom found sustenance chiefly in agricultural pursuits.

New life and fresh impetus were given to this small town when in 1839 the Prussian Government commenced boring for Rock-salt; and again, when, in 1856–7, the sinking of two shafts, commenced five years before, was successfully completed, laying open immense deposits, not only of the finest Rock-salt but of various other salts, notably valuable Potash salts, whose existence here had hitherto not been suspected. The town now numbers over eleven thousand inhabitants; numerous chemical factories have sprung up around it, turning out tens of thousands of tons of various chemical products per annum; while the mines (of which there are two) yield hundreds of thousands of tons of minerals annually.

Stassfurt is situated on the Bode, in the Province of Saxony, and is about 12½ miles S.W. of Magde-

burg. It has a station on the Magdeburg-Leipzig Railway, and has thus facility for distributing its productions over the country.

The formation in which the Rock-salt and Potash salts occur is the Bunter Sandstein.

It is not the object of this paper to discuss the geology of the district, nor the origin of these remarkable deposits, but to give a short account of the discovery and opening up of the deposits, a description of their mode of occurrence, and the method of mining them.

The Prussian Government, influenced by the results of the careful survey made the previous year, and acting upon the advice of competent geologists and engineers, whose examination of the district had led them to believe that the borings they recommended would discover valuable beds of Rock-salt, commenced in 1839 a bore-hole at Stassfurt.

Boring was continued, not unaccompanied by many difficulties, till 1851, when a depth of 591 metres (1938 ft.) was reached, and the bore-hole suspended in Rock-salt, the upper layers of which had been struck at a depth of 256 metres.

Successful though the boring had been in proving the existence of salt deposits over 1000 feet in thickness, it yet seemed doubtful at first whether they would have any commercial value; for instead of a saturated solution of common salt, as was expected, the solution for the last 157 metres bored was found to contain only 17·9 per cent. of common salt in the solid matter, while there was a much larger propor-

tion of the chlorides of magnesium and potassium. 100 parts of solution gave

Sulphate of Magnesia . .	4·01 parts	=	12·8 %
Chloride of Magnesium . .	19·43 „	=	62·1 %
Chloride of Potassium . .	2·24 „	=	7·2 %
Chloride of Sodium . .	5·61 „	=	17·9 %
	31·29		100·0

This was disappointing; for neither the salts of magnesia nor even of potash were sought after, but the chloride of sodium, or Rock-salt. There were not wanting, however, scientific men who were able to account for this large proportion of foreign salts in the deeper parts of the bore-hole, without accepting the general belief that the deposits at those depths were fairly represented by the composition of the saturated water from the bore-hole. It was pointed out by them that on the assumption that the magnesian and other salts occupied only the upper strata of the deposits, the drainings from which would naturally find their way into and mix with the water in the bottom of the hole, the phenomenon would be explained.

This idea was further strengthened by the bringing up occasionally out of the bore-hole small pieces of pure Rock-salt; and in December, 1851, and January, 1852, the Government commenced sinking an engine-shaft and a winding-shaft, with the object of laying open and working the Rock-salt.

Both shafts reached a depth of 335 metres (1098 ft.) in five years, and sinking was suspended in pure Rock-salt, the upper layers of which were met with 256 metres from surface.

The shafts being completed, arrangements were at once made for raising the Rock-salt, and in 1857 the work of regular extraction commenced, and has gone on uninterruptedly ever since, till the annual output amounts to over 50,000 tons.

The Prussian Mine is situated near the boundary of the Duchy of Anhalt; and seeing the success attained by their neighbour, the Government of the Duchy commenced boring for Rock-salt in 1857, and by July of the following year, after boring through no less than 163 metres of various salts, a depth of 314 metres had been reached. Boring was now suspended, and the sinking of two shafts was commenced at the village of Leopoldshall, 1168 metres from the pioneer shafts of Stassfurt. The result was brilliant, and the rich deposits of Leopoldshall have been called "the gold springs of Anhalt." The Potash beds were struck at a depth of 150 metres, and the pure Rock-salt at 195 metres; sinking was continued in the latter 25 metres, making the total depth of the shafts 220 metres.

The dip of the beds in Leopoldshall mine is about 44°, and in Stassfurt mine about 33°; the general strike in both mines is about north-west and south-east.

The following is a tabular view of the depths and thicknesses of the various strata sunk through in the Prussian and Anhalt shafts:

	Prussian Shaft.		Anhalt Shaft.	
	Thickness.	Total depth.	Thickness.	Total depth.
	m.	m.	m.	m.
a. Diluvium	8·5	8·5	6·3	6·3
b. Variegated marls, roe-stone, and limestone of the Bunter Sandstein	180·7	189·2	—	—
c. Gypsum and Anhydrite . .	60·3	249·5	117·0	123·3
d. Saliferous clay . . .	6·6	256·1	27·3	150·6
e. Potash salts . . .	49·6	305·7	44·0	194·6
f. Pure Rock-salt . . .	28·8	334·5	25·1	219·7

Both these mines, it will have been observed, were opened for the purpose of winning Rock-salt, it never having occurred to the proprietors that beds rich in Potash would be found, and that moreover they would become by far the most valuable, as they are now the most extensively worked, of the deposits.

Large heaps of the mixed salts, which could not escape notice owing to their prevailing red colour, had accumulated at surface from the sinking of the shafts, and were variously designated bitter, variegated, or rubbish salts (Abraumsalze), and supposed to be valueless. Chemical analysis, however, led to the important discovery that the red salts contained a considerable percentage of chloride of potassium (muriate of potash); that this formed one of the constituents of a new mineral, to which the name of Carnallite was given; and that in these beds overlying the pure Rock-salt there was apparently an almost inexhaustible quantity of Potash, representing immense wealth.

A careful and systematic chemical examination of he whole series revealed the fact that the Potash

salts were mainly confined to the upper strata, that the intermediate layers contained Carnallite in less proportion mixed with salts of magnesia, lime, &c., and that the pure Rock-salt underlay the whole; and led to the division of the Stassfurt series into four groups or zones, which were designated by the names of the most characteristic mineral of each group. In descending order these are the Carnallite Group, the Kieserite Group, the Polyhalite Group, and the Anhydrite Group, a short description of which may now follow, premising however that this division into groups is purely arbitrary, and that there is no natural division between them, but that the one passes by insensible gradations into the other.

Taking, for convenience, the groups in ascending order, we have first the

Anhydrite Group.—This is the lowest of the series, and consists of pure common salt, through which horizontal galleries 330 metres in length have been driven; and since the beds have a dip of about 30°, the true thickness of the salt, as far as explored, is 165 metres, or 541 feet. Small parallel strings of Anhydrite run through the salt (hence the name of the group), without, however, affecting its purity to any material extent. These are termed by the miners "year's rings," from a supposition that they mark the original yearly amount of deposit.

The Rock-salt is generally clear and colourless, crystalline, and splits into beautifully perfect and transparent cubes. Its specific gravity is 2·20 to 2·16. The average composition of the group is

about 95·5 per cent. chloride of sodium, and 4·5 per cent. sulphate of lime.

At the Anhalt mine—seldomer at the Prussian mine—specimens of salt of a transparent blue colour are sometimes found. This colour, which is ascribed to enclosed carbonic acid gas, disappears when the salt is strongly heated, or dissolved in water.

Specimens of a red colour have also been met with.

Polyhalite Group.—Next in ascending order is the Polyhalite group, so-called from the presence of the mineral Polyhalite, a compound salt of the sulphates of lime, magnesia, and potash, $2CaSO_4 . MgSO_4 . K_2SO_4 + 2H_2O$. It is amorphous, of a light-gray colour, and dull lustre. Its specific gravity is 2·72. Like the Anhydrite, it occurs in strings, forming divisional planes in the Rock-salt. The group, whose thickness is about 31 metres, is composed of 91 per cent. Rock-salt, 6·6 per cent. Polyhalite, and a little magnesic chloride, and Anhydrite.

Kieserite Group.—This group, which has a thickness of about 28 metres, consists of some 65 parts Rock-salt, 17 Kieserite, 13 Carnallite, 3 chloride of magnesium, and 2 Anhydrite.

The mineral Kieserite, which lends its name to the group, is a sulphate of magnesia, $MgSO_4 + H_2O$, but differing from the ordinary sulphate (Epsomite, Epsom-salt) in having 6 eq. of water less. Its colour is chalk-white, sometimes yellow, and it is semi-transparent to opaque. Its specific gravity is 2·52. It readily absorbs water from the atmosphere, and passes

slowly over into Epsom-salt. Kieserite is used to some extent in the manufacture of sulphate of potash, Epsom-salt, and various other purposes.

Carnallite Group.—This is the group *par excellence* of the Stassfurt and Leopoldshall deposits. In the Stassfurt mine its thickness is 21 metres (nearly 70 feet). It overlies all the other deposits, and surpasses them all in intrinsic value. The average composition of the group is, according to F. Bischof, Carnallite, 55 parts; common salt, 25; Kieserite, 16; chloride of magnesium, 4. It is the Carnallite which is the valuable part of the so-called Potash salts, as it is the chloride of potassium which is the valuable portion of the Carnallite. The composition of this mineral is ($KCl . MgCl_2 + 6H_2O$):

Chloride of Potassium	26·76 %
Chloride of Magnesium	34·50 %
Water	38·74 %
	100·00

Its prevailing colour is red and reddish-brown, from the presence, it is said, of a very small quantity of iron; but sometimes it is of a pure clear white. The writer has seen at Leopoldshall mine galleries some 30 feet wide being driven in a solid mass of beautifully white crystalline Carnallite; whereas at Douglashall mine (to be referred to presently), where immense beds may be seen laid open for stoping, there is no white Carnallite of consequence, the whole being of a reddish colour. Its specific gravity is 1·62. It is very deliquescent, and soon becomes soft on exposure to the air.

The Carnallite occurring mixed with other minerals, it is not found practicable to raise it in a state of purity; it comes to surface therefore, and is supplied to the chemical factories, in a crude state, containing on an average about 66 per cent. of the pure mineral, which yields about 17½ per cent. of chloride of potassium.

On being drawn to surface, the crude Carnallite is discharged into railway trucks, and delivered direct to the chemical works in the neighbourhood, at the normal price of 8s. per ton for 60 per cent. Carnallite.

Neither the Prussian nor the Anhalt works have any chemical factories of their own.

The rapid development of this new branch of industry will be seen from the following figures:

The systematic raising of Carnallite commenced at the Stassfurt mine in 1860, in which year 279 tons were raised; and at the Leopoldshall mine in 1862, when 215 tons were raised. In 1864 the quantities had greatly increased, Stassfurt in that year raising 57,330 tons, and Leopoldshall 58,337 tons; and ten years later, in 1874, Stassfurt sent to the factories 124,922 tons, while Leopoldshall delivered no less than 301,419 tons.

In 1861 there was *one* chemical factory at Stassfurt for treating the Carnallite, in 1874 there were 33. Some 1100 workmen are employed in the mines, and about 3000 at the chemical works.

In 1872 the following chemical products were manufactured by these works from the produce of the two mines:

60,000 tons chloride of potassium.
10,000 „ sulphate of magnesia (Epsom-salt).
6,000 „ „ soda (Glauber's salt).
5,000 „ chloride of magnesium.
5,000 „ potash manures.
1,250 „ sulphate of potash.
1,250 „ carbonate of potash.
100 „ bathing salts.
35 „ bromine compounds.
20 „ boracic acid.

The following figures will show that much less importance is attached to the production of Rock-salt than of Carnallite:

	Stassfurt raised Rock-salt—tons.	Leopoldshall raised Rock-salt—tons.
In 1857 . . .	12,362	—
„ 1861 . . .	41,023	527
„ 1864 . . .	44,168	1,712
„ 1874 . . .	51,650	23,233

In addition to the minerals above described, there are various others of less importance found in connection with the upper beds, as *e.g.* Kainite, Sylvin (KCl.), and others, but the first-mentioned is the only one calling for especial remark here.

Kainite ($K_2SO_4 . MgSO_4 . MgCl_2 + 6H_2O$) is an important mineral, found occasionally in Stassfurt, but occurring as an extensive bed in Leopoldshall mine, overlying, or rather overlapping, the upper or Carnallite group. It was but little known till 1865, since which time there have been many thousands of tons (in 1871 a maximum quantity of 32,682 tons) raised per annum. It owes its value to its large percentage of sulphate of potash—36·34 per cent.; which makes it very useful as a potash manure, for which it is mainly used.

The method of working these mines may now be briefly described, and this paper concluded by a short description of Douglashall mine—a mine in the neighbourhood of Stassfurt, and worked exclusively for Carnallite.

The Stassfurt mine is worked, as has been observed above, by two shafts (a third, not so deep as the others, serves to aid the ventilation), which are connected by several cross-cuts. There are six working levels. The ground is broken with the aid of blasting-powder by overhand stoping.

Main levels or galleries 2 metres high are first driven on the strike of the beds; cross-cuts of the same height, and 25 metres wide in Rock-salt, and 9 metres wide in Carnallite, are next driven from these at right angles. The cross-cuts are then stoped away to a height of 8·5 metres, an arch or roof of four metres being left between the stope or stall and the level above.

Pillars are left between the stalls 13 metres wide in Salt and 6 metres wide in Carnallite.

Holes for blasting are bored either by drill and hammer or by the "Elisabeth machine"—a drill like a carpenter's screw-auger, working in an upright iron frame, and turned by a winch-handle. A hole 2 ft. deep is bored by this machine in a few minutes by two men without stopping.

Winding is effected by two 150 H.P. engines; the cages in the shaft are two-decked, each deck carrying two wagons, whose capacity is about 14 cwt. The cages are suspended by iron-wire ropes. A 30 H.P.

engine is employed for sending the workmen up and down the mine. The water is pumped out of the mine by a 200 H.P. Cornish engine.

At Leopoldshall mine the two shafts are walled and perfectly dry, so that no pumping-engine is required.

Two 70-H.P. air-compressing engines throw air into the mine for ventilation, and for driving boring-machines and underground winding-engines.

The system of working is by pillar and stall, similar to that followed at Stassfurt mine.

The minerals are trammed to shaft by horses (who live entirely underground), and drawn to surface in the same wagons, on two-decker cages, by three winding-engines of 140, 116, and 50 H.P. respectively.

The Elisabeth machine is used for boring, as also a rock drill with screw borer like the other, but driven by compressed air; this latter, which is a modification of and an improvement on the simple Elisabeth machine, is a very effective drill.

Douglashall Mine, the only other mine in the neighbourhood in which Carnallite has been laid open by shafts, is situated near the village of Westeregeln, 12 miles north-east of Stassfurt, and 14 miles from Magdeburg.

The mine and chemical works in connection therewith belong to a private company. The Carnallite beds have been laid open by two shafts, 14½ feet diameter, 53 metres apart, and communicated by cross-cuts. Sinking was commenced in 1871–2; the main beds of Carnallite were met with in No. 1 shaft at a

depth of 234 metres, and in No. 2 at a depth of 159 metres. Sinking was continued to a depth of 279 metres in solid Carnallite. The shafts, being walled with brick and cement, are perfectly dry; no pumping machinery is therefore required. The winding-engine is of 150 H.P.; the cages, which are double-decked and carry four trams at a time, are suspended by flat wire-ropes. The workmen are lowered and raised in these cages.

The beds, the stratification of which is very distinct, though not always running in straight lines but often curved and flexured, are nearly vertical; their thickness (as far as explored) is therefore represented by the length of the levels driven across their plane of strike or direction, and is proved to be in the two deepest levels—reckoning only the richer and paying seams—about 180 feet.

The composition of the beds is chiefly Carnallite, interstratified with thin seams of common salt and Kieserite, with occasional nests of Boracite ($2Mg_3B_8O_{15} . MgCl_2$ = the composition also of the mineral Stassfurtite).

These minerals occur for the most part in regular and parallel, but sometimes, as has been mentioned, in highly flexured and contorted bands; the Rock-salt, the most abundant of the impurities, occurring in seams as much as 1½ foot in thickness; and since they present a variety of colours, from the red of the predominating Carnallite to the dingy-white of the Rock-salt, and the grayish-white or the yellow of the Kieserite, the whole produces, when illuminated

underground, a very fine and singular effect. Except in small seams of a few inches in thickness, and hence of no value, no common salt has hitherto been found here.

The method of working is as follows: A main cross-cut is driven from the shaft through the beds at right angles to their bearing, main galleries are then driven along the hanging and foot-wall sides of the deposit on the strike; these are carried 4 to 6 metres wide, and 2 metres high, and form the permanent roadways to the shaft.

From these galleries, cross-cuts 9 metres in width, and 2 metres in height, which are to be the future stopes or stalls, are now put out at regular intervals along the whole length of ground laid open. The ground being thus cut up into blocks or sections, and perfect ventilation effected, is now ready for stoping. The mineral is stoped away from the backs of the cross-cuts to a height of 14 metres (46 ft.), the broken mineral being allowed to accumulate underfoot for convenience of the miners. The stalls are thus 9 metres wide, 14 metres high, and often 40 metres long, while the pillars left to support the roof are 7 metres wide. To give additional strength to the roof, which is 7 metres in thickness, it is slightly arched.

The Carnallite is broken down by blasting (gunpowder, but no dynamite is used), the holes being bored by the ordinary drill and hammer. No timber whatever is used for propping or staging.

The system of working adopted renders available about 45 per cent. of the mineral.

Operations are confined to the 6th (250 metres) and 7th (271 metres) levels. In the 6th level, a length of 313 metres (1026 ft.) has been opened in one continuous run of good Carnallite, having an average thickness of 48 metres (157 feet).

In the 7th level, 213 metres (698 ft.) have been driven on the strike of the beds and in rich Carnallite, the mean thickness being about 63 metres (206 ft.), and the forebreast of each of the levels is still (February, 1878,) in solid Carnallite, which shows no signs of falling off in value.

There were at the time of the writer's visit, it was calculated, no less than 900,000 tons of Carnallite laid open in the two deepest levels, yielding from 15 to 18 per cent. of chloride of potassium, and taking into account the width and height of the beds now being worked, every metre advanced in the direction of the strike of the deposit would lay open 1500 tons of Carnallite.

This mine is in its infancy, and with the mines of Stassfurt and Leopoldshall, will doubtless continue for a long period to yield immense quantities of Carnallite, which in its turn will supply to the arts and manufactures large quantities of valuable potash salts, as well as the less important but increasingly useful magnesian and other compounds.

Royal Geological Society of Cornwall.

THE SIXTY-SIXTH

ANNUAL REPORT,

ETC. ETC.

PENZANCE.
1879.

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George Williams, Scorrier.

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John Rowe, The Terrace, St. Just.
Stephen Thomas, Redruth.
Thomas Treloar (formerly of the St. John del Rey Mines), London.

Names of Honorary Members and Associates whose exact Addresses are unknown.

Benson, W. H.
Bowman, J.
Hall, R. T.
Hawkins, Thomas.
Phillips, John.
Treloar, Thomas.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

On seeing so fairly representative an assemblage of our now veteran Society, I may, on this its annual meeting, congratulate you on the continued prosperity and increased usefulness of the Institution. A period of financial trouble and general distress, unprecedented in our times, has interfered but little with the fulness of your list of subscribing members; and if we have no striking novelties to set before you, still the occasional contributions of specimens to your Museum, and books to your Library, are a sufficient testimony to the Society's having made a good name, and mustering many friends both at home and abroad.

But although our numbers are happily undiminished, we have lost during the past year men of mark, to whose qualities and actions we may advert, with a mingled feeling of regret for their removal from among us, and of pride in their having belonged to our body. Foremost among our deceased ordinary members is a distinguished native of the county, Sir Richard Vyvyan, Bart., who was a character deserving of a higher appreciation than of late years he met with. Born in the first year of the century, the scion of one of the oldest Cornish families, he early succeeded to the baronetcy, and whilst not omitting to take his part in active local affairs as an officer of yeomanry, devoted himself chiefly to politics, and after entering Parliament in 1825, soon became a prominent figure, especially in the stormy debates which preceded the first Reform Bill. At this time his ability, courage, and eloquence, contributed to indicate him as the "Rupert" of his party, the probable future occupant of a high position in the government of the country. But with the changes caused by the passing of the

bill, an altered feeling seemed to take possession of Sir Richard. He represented Bristol in the new Parliament for some years, and afterwards Helston till 1857; but inclined as he was from an early age to philosophical studies, he now, more than before, occupied himself with enquiries in many branches of natural science. Here came into play an extensive and well-selected library, with the contents of the whole of which he seemed to be familiar. He had been admitted a Fellow of the Geological Society of London in 1825, and of the Royal Society in 1826, and his attention was so occupied with questions, often of an abstruse character, in Astronomy, Geology, and Physiology, that it was no wonder he should be suspected by many who conversed with him of being the author of the anonymous *Vestiges of the Natural History of Creation.* This work, it may be remembered, greatly excited the reading public of a generation ago, and though roundly abused at the time, played, without doubt, an important part in preparing men's minds for the reception of the Darwinian views, to which so large a proportion of naturalists have given their adhesion.

Sir Richard Vyvyan never pursued either of these studies in a practical form, and thus his connection with our Society and that of London took the shape rather of a desire to promote and to assimilate the work of others, than to labour in the actual field himself. His assiduity and power of appreciation remained the same through all the latter years of his life up to a recent date. Very rarely among the most highly cultivated of men would so remarkable a versatility be found. From the treatises of Herschel or Airy to the last French novel, from Croll's calculations on the Glacial Period to disquisitions on the music of ancient and modern composers, Sir Richard would continue to converse, now in a light and enquiring tone, anon in an impressive strain in which every well-chosen word struck home. The recollections of an acquaintance of a great many years, begun after he had ceased to be a shining light in the political world, assure me that Sir Richard Vyvyan was a man of very uncommon type, and that if his undoubted powers were not so effectively used as under different guidance they might have been, his death is the loss of one of the worthies of Cornwall.

Another of our Members was so well known in this neighbourhood that I need do little more than remind you of the useful services of Mr. Samuel Higgs as Secretary of your Society. It was not here alone, but in many other lines of public utility, that Mr. Higgs won good opinions. And when he left this country to take the chief management of the Wallaroo Copper Mines in South Australia the same fortune seems to have occurred to him there. His activity was proved in various spheres of usefulness, and when at length in the early part of the year he was unfortunately killed in the prime of life, by being thrown from his horse against a waggon-wheel, the large concourse of mourners who followed him to the grave, and the eulogistic notices in the local papers, testified to the estimation in which he was held in the country of his adoption.

Mr. Higgs, as you may remember, was a contributor to your memoirs; and his public spirit, in addition to the many years during which his family was connected with Penzance and many of the neighbouring mines, will have caused the sad tidings to be received with much sorrow by many of his fellow-townsmen.

From the list of Honorary Members we have to deplore the loss by death of two eminent men, who both, in a long lifetime much occupied with such studies, did good service to the cause of geological science, although in very diverse directions. Bernhard von Cotta, who for thirty-two years occupied the position of Professor of Geology at the Mining Academy of Freiberg, in Saxony, was born in 1808 at Tharandt, near Dresden, where his father was the principal of a college for teaching Forestry. He studied at Freiberg and Heidelberg, and in the years 1836–40 became a noted writer on geological subjects, and was attached to the practical work of carrying out the survey for a geological map of Saxony, commenced by the late Professor Naumann. On the transference of that distinguished philosopher to the University of Leipzig, Cotta was appointed in his stead, and from the testimony of his pupils appears to have been lucid, painstaking, and friendly as a teacher, whilst he worked indefatigably at observation in the field, and at a numerous series of books dealing with different branches of his favourite subject. I may pass by a number of his

works which were intended mainly to diffuse sounder notions of geological facts and reasoning among readers belonging to the general public. Only a few of those have been presented in an English dress, but they have most of them enjoyed a considerable popularity among the intelligent reading classes of Germany. Before the year 1850 he conceived the idea of gathering together in one continuous series full and well-chosen descriptions, by men of competent powers, of lodes or districts noted for their metallic mines; and under the name of "*Gangstudien*," or "Studies of lodes," several volumes of great interest to the miner were compiled. Shortly afterwards von Cotta threw together into a single volume, published in 1855, and then again in an amplified form, a general and systematic account of the phenomena connected with the repositories of ores, under the title of "*Lehre von den Erzlagerstätten.*" In these latter works, where the author takes up the ambitious part of describing the mining districts of all countries, deriving in some cases his knowledge from actual inspection, but relying in others upon somewhat uncertain *data*, it is no wonder if some portions of the work should be unequal to others. But besides the vast amount of descriptive matter thus harvested and arranged for the benefit of readers interested in that part of geology most closely connected with mining, another valuable feature enters into these works in the shape of a digest of the literature of the subject, whereby you may refer to what has been published, not only as separate works, but as partial memoirs, in all the languages of Europe.

The feeling evoked by the recent loss (14th September last), after several years of ill-health, of this favourite professor and prolific author, is taking the form of a subscription among his former pupils to erect a simple monolith monument to him at Freiberg, and to establish a fund, with his name attached to it, for the assistance of deserving students at the academy.

I have the more reason for insisting on the value of von Cotta's labours, that two of our younger Members, from whom we have to expect much good work, Mr. A. Pendarves Vivian, and Dr. Le Neve Foster, had the advantage of being students under the late Saxon professor at Freiberg.

By the death, at an advanced age, of Mr. Thomas Sopwith, F.R.S., F.G.S, we have lost a donor to our Museum, and an author of sundry works more or less connected with geology and mining. Passing all his earlier life at Alston Moor and Newcastle-on-Tyne, and much occupied with surveys of the lead mines and collieries, he was long associated with Buddle, the leading coal-viewer of his time, and the illustrious Robert Stephenson. His ingenuity, wealth of anecdote, and facility in planning and drawing, made him a welcome ally to Dean Buckland and others among our leading geologists; and he conferred a real benefit on the student by the skilful devising and execution of the solid block models of geological phenomena in which the different strata are represented by variously-coloured woods.* As a Commissioner for regulating the Forest of Dean Mines, and afterwards as manager of the extensive lead mines of Mr. Beaumont, in Durham and Northumberland, Mr. Sopwith, with the enjoyment of the good opinion of all classes, passed some thirty years of his life in the ordering and conduct of mining affairs.

Of your Associate Members I cannnot but testify to the value of Captain William Vivian, whose death took place at the iron mine of Mwyndy, in Glamorganshire, of which for some years he had been manager. He had long been a prized and trusted agent in the employ of the Messrs. Taylor; and from the period when, years ago, he had the management of the copper mine on the Orme's Head, North Wales, he had applied himself to a study of the minerals produced at his mines, and even to microscopic examination. He was, in fact, a good example of the eminence in technical experience and observing power which, with little or no assistance from the outside, has in so many cases been attained by the industry and reflective mind of our miners and mine captains.

In the first Address which I had the honour to offer to you from this chair I ventured to suggest several prominent subjects as being particularly desirable for investigation by those interested in the geology of Cornwall. In this I was only following out in a little

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* The Society possesses a series of these models, which are placed on the table for inspection.

more detail the call of my predecessor, the late Mr. Augustus Smith, of Tresco Abbey, to the younger generation of Cornishmen, to take up the studies which had been so successfully cultivated by the fathers of this Society, and of which your *Transactions* form an honourable monument. It is with much satisfaction that I can bear witness that under most of these heads some good work has been done within the last seven years, as the newer volumes of the *Transactions* will testify. But the field is still extensive, and the labourers are few; whilst on some of these subjects, so great is the number of observations and comparisons to be made, that I believe those very writers to whom I refer will be among the first to admit that they have by no means settled the questions which they have attacked.

In the meanwhile contributions to the geology of the county have been made in other pages and from other sources, some of which may be unknown, or have been only cursorily glanced at by members of this Society; and it appears to me therefore, as a sequel to such earlier suggestions, to be not without advantage to refer to some of those points among the newer writings which should principally interest the dwellers in this peninsula.

Perhaps there is no district in the world more interesting, and at the same time involving more puzzling questions, than this Penwith in which we are now assembled. You will recollect that whilst numerous descriptions of portions of it emanated from our earlier observers, a paper was contributed, the first in vol. ix., by our excellent benefactress, the late Miss Elizabeth Carne, on the rocks of the country lying to the west of a line drawn from Marazion to Hayle. There is a great deal in this communication with which I cannot agree, but much with reference to the features of the rock masses which is very suggestive. Especially in the lucubrations on the affinities of the different classes of rock to be seen within a good walk of Penzance, and upon their relations to each other, has the observant authoress raised a number of curious questions. But satisfactory *data* as to the true character of composition of these substances were wanting; and, greatly to the advantage of further reasoners, several important researches of an accurate order of investigation into their chemical character and microscopic appearances

have been brought forward in accordance with the requirements of the newer petrology.*

Thus Mr. J. Arthur Phillips, himself a Cornishman, in 1875 treated of the rocks of the Cornish mining districts. He gave a detailed description and analysis of the clay slate or killas, 1st, From Polgooth Mine, at adit level; 2nd, Polgooth, 80 fathom level; 3rd, the same mine, 100 fathom level; 4th, Polmear Mine, at 40 fathoms deep; 5th, from "Sanctuaries," St. Austell; 6th, from Dolcoath Mine, 215 fathom level; 7th, roofing slate, Delabole; 8th, Botallack, surface near lode; 9th, Botallack, 130 fathom level; 10th, Huel Seton, 160 fathom level. Then came a similar examination of the "greenstones" of Trehill, in the parish of St. Kew; 2nd, of Botallack; 3rd, from Rose Hill, near Castle Horneck; of the granites of Carn Brea, Botallack, and Chywoon, Morvah; and four varieties of elvan, viz., those of Pra Sands, near Sydney Cove; Tregoning Hill, Breage; Mellanear, Hayle; and Trelissick Creek. From these investigations it was announced by the author, in strong opposition to views which had for some years been propounded by many British and American geologists, that "neither granites nor elvans could result from the rearrangement, by heat or otherwise, of the constituents either of one or of any number of such slates."

In 1876 Mr. Phillips read another paper before the Geological Society,† in which he gave as a preface the opinions of some of the older authors upon the character and nomenclature of the dark green rocks which near Penzance and in St. Just border upon the granite, and quoted the statements of the late Mr. David Forbes as to their being nothing else than "clay-slates altered *in situ*, and possessing none of the properties of greenstones beyond the greenish tinge which coloured them." It has always appeared to me that this sweeping generalization was founded upon very inadequate enquiry, and we may follow Mr. Phillips with great interest in the close observations which he has made on the composition of these substances and on their appearance in their slices

* *Quart. Jour. Geol. Soc.*, vol. xxxi. p. 319.

† Ibid., vol. xxxii. p. 155.

Petherwin. In the latter both an anorthic felspar and the augite appear perfectly fresh, although ilmenite, very often one of the constituents, is decomposed to a grey substance.

Bands of what is locally termed "dun-stone" occur between Trevose Head and Launceston, and although of very similar ultimate ingredients with the massive crystalline greenstones, appear, from their occurrence and their vesicular structure, to have been ancient lava flows. These, as also some of the hornblendic schists, can hardly have been other than contemporaneous with the killas; but the massive crystalline greenstone and hornblende rock, doubted and buffeted to and fro, as it has been by some authors, is now rehabilitated, and endowed with a certain amount of independence, as rock of igneous origin, which frequently bears marks of having been intrusive. Its relative antiquity is another question; and, although it may be difficult at present to assign to it any definite geological age, it appears pretty certain that it is more ancient than the granite and elvan.

In 1876 a paper was brought before the Geological Society, "On the Metamorphic Rocks surrounding the Land's End Granite," by Mr. S. Allport, an eminent authority among our microscopic petrologists. The earlier part of his communication works out with more detail than the subject has hitherto received, the alteration of the killas by the granite. Thus the conversion into tourmaline-schist, and into mica-schist, and the infiltration of quartz, with production of more or less abundant tourmaline of divers colours, and of three kinds of mica, facts which have long been known to some Cornish observers, are here described with all the minutiæ belonging to a skilful microscopic investigation. On the subject of the abundant fluid cavities occurring in the quartz of the granite, in that of the lodes, and of the altered killas, he enters into a careful enquiry into the phenomena, which cause him to oppose the ingenious theory brought forward by Sorby; viz., that by measurement of the bubble contained in these microscopic cavities, we might calculate approximately the depth and the pressure under which such substances were formed.

Following up Mr. Phillips' more particular enquiry, Mr. Allport appears to entertain no doubt, quoting their occurrence at several

places in the Penzance district, that the "greenstones"—many of them at present thoroughly hornblendic rocks—have undergone a pseudomorphous change on a great scale, by which the augite, originally their chief constituent, has often entirely disappeared, but may in many cases be traced by the outline of its crystals, now occupied by fibrous aggregated groupings of one of the varieties of hornblende. Besides referring to many of the above-noticed localities, Mr. Allport forms an interesting opinion on that singular mass of serpentinous rock, Clicker Tor, one aspect of which met us on the old coach-road from Liskeard eastward, and the other confronts us at Menheniot station. It is pronounced to be an intrusive mass of olivine-dolerite, where the gradual changes of the olivine and augite have brought it to the condition of an imperfect serpentine. It is satisfactory to obtain so strong a confirmation of the novel view of the ancient importance of the augitic element in the greenstones, and not less so to find that both authors agree in recognizing the accuracy in mapping and the judgment in reasoning upon these rocks, which are shown in the works of one who deserved well of Cornwall, the late Sir Henry De la Beche.

There is another wide field of geology, in which the seed sown is unusually abundant, and the harvest that may be expected far richer than the average. Mr. Ussher, long attached to the Geological Survey in Devonshire, has devoted much of his vacation time to a study of the Quaternary, and of what he terms the Historical, Geology of Cornwall. And to supplement what he has examined with his own eye, he has collected a great mass of highly-interesting material, some of which is culled from the volumes of your *Transactions;* other portions from divers independent works, and from a variety of scientific periodicals. These researches cannot fail to be highly attractive to all who take an intelligent interest in the action of the natural forces working around us, and to those who have learnt to appreciate the bond which unites geology with archæology, especially among the vestiges of pre-historic man, and the proofs of the great changes which have modified the surface of this county since his first appearance here.

Some of Mr. Ussher's results have been laid before the Geological Society, and a series of papers have been printed in the *Geological*

*Magazine.** Among these latter the first and second take up the historical evidence under three heads; viz.:

I. Accounts of unusual disturbances of the sea by contemporary observers.

II. Records of disastrous inundations preserved in old chronicles.

III. Traditions of the Lyonesse, and probable references of the ancient geographers and historians to the Scilly Isles.

IV. The insulation of St. Michael's Mount, and the identification of Ictis. †

In a second part, taking up the Pleistocene Period, the author divides the subject into the following sections:

1. Oldest superficial deposits.
2. (*a*) Boulder gravels, (*b*) Raised beaches, and (*c*) Head.
3. Submerged forests and stream-tin gravels.
4. Recent marine and blown sands.

It would not be fair to occupy your time in extracting any of the interesting details which have been thus brought together, and which have been examined by the author, where they are still accessible. The back numbers of the useful and very readable magazine in which they appeared are readily procurable at a modest price, and I am in hopes that Mr. Ussher is putting his collected notes and gleanings into a single volume, which certainly ought to find a place in every library in the county. ‡

Thus far I have thought it needful to dilate upon subject-matter which ought to have a special charm for the minds of thinkers who reside in this county. We have now heard something of the newer doings of observational, chemical, and microscopical geology; but another branch of the subject (experimental geology) has for the last thirty years found an industrious worker and lucid expositor in your distinguished foreign member, M. Daubrée, the Director of the School of Mines at Paris. He has now in the present year issued a lordly volume, § in which are collected, along with the history and the general reasonings on the

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* See the *Geological Magazine*, January, 1879, p. 28.

† *Geological Magazine*, March, 1879, p. 102.

‡ Since the meeting Mr. Ussher has very handsomely presented to the Society a large number of copies of his work for gratuitous distribution.

§ *Etudes Synthéthiques de Géologie Expérimentale.* Dunod, Paris, 1879.

subject, the numerous experiments—chemical, physical, and mechanical—which he has laboriously carried out in order to illustrate opinions, and to solve questions connected with various geological phenomena. Already a number of these researches have been published in the *Annales des Mines*, and elsewhere. I have had the pleasure, in more than one of my annual addresses, of bringing before you some of his very curious chemical and mineralogical results; and our curator, Dr. Foster, in your last volume of *Transactions*, has, in describing East Huel Lovell, translated at some length Daubrée's description of the experiments which he carried out some years ago for the purpose of elucidating the genetic history of the repositories of tin ore, and the rocks with which that ore is associated. The stanniferous deposits are evidently a favourite subject with the accomplished author, and it is to them that a great part of his first chapter is devoted. Among them he particularly dwells on those rocks which are seamed by a great number of tin-bearing strings, comparing those of sundry continental localities with Carclaze, near St. Austell, and with St. Michael's Mount. It has long been a matter of observation and comment, that certain groups of minerals are found as the associates of cassiterite or tin ore; thus from Cornwall to Bohemia, in the far north in Greenland and Eastern Siberia, in the extreme south of Asia (at Bangka and Blitong), in North America, and again in Australia, the occurrence of fluorine minerals, either containing or grouped with the elements silicon, boron, phosphorus and arsenic, tin and tungsten, caused Daubrée, so long ago as 1841, to ascribe a leading part to fluorine. Experimenting on the action of this element, and of chlorine, he has been able synthetically to form minute but recognizable crystals of tin-stone itself, of apatite, and of several of the other minerals which, although sometimes very rare, are so generally more or less to be met with as a characteristic group in the tin deposits.

These experiments were parallelled by others of an analogous kind, in which the oxide of titanium took the place of that of tin. Daubrée calls to mind the elegant mineral groups of certain parts of the Alps, particularly Oisans and the St. Gotthard district, where again we have charming crystals of apatite, with mica,

fluor, tourmaline, and axinite; and the experiments point to the conclusion that, in many cases at least, the oxides of titanium, known to mineralogists as rutile, anatase, and brookite, have been carried and deposited in their natural localities by the instrumentality of fluorine. Again, the reaction of fluoride of silicon upon alumina was such as to produce a substance having most of the characters of topaz, another mineral found, somewhat sparingly it is true, in many of the tin-bearing localities, and amongst them at the Mount and at St. Agnes.

Investigations of a similar character have been carried out with brilliant success in the greater perfection of the products, by M. H. St. Claire Deville, M. Hautefeuille, and Messrs. Feil and Frémy. On the other hand, the highest of French authorities, M. Elie de Beaumont, pointedly referred to these conclusions of M. Daubrée's as being of signal importance in reasoning upon the origin of granite, and upon the effects which that most amply discussed of rocks has impressed upon the various stony substances with which it comes in contact.

Ladies and Gentlemen,—I have thus set before you in a very abbreviated form a sketch of the newer writings which affect some of the most prominent points in Cornish geology. Four times I have had the honour of receiving the suffrages which have placed me in the presidential chair; and now, at the end of eight years, it is no small satisfaction to look back over a tenure of office, rendered easy and pleasant by the unity of feeling which has actuated your Councils, and at the same time to entertain a confident opinion that in that period the Society has not become less useful than formerly. One final responsibility has devolved upon me, that of recommending to you a successor certain to uphold the character of the Institution; and I feel assured that in proposing as your future president a gentleman already connected with you by other ties, and one who has lately shown in print that he has not forgotten the lessons of Breithaupt and von Cotta—Mr. A. Pendarves Vivian—I shall act in accord with the wishes of all our members, and discharge with your full approval the last duty which devolves upon me before retiring from your chair.

REPORT OF THE COUNCIL.

THE Council beg to present this, the Sixty-sixth, Annual Report of the proceedings of the Society.

The past year has not been fruitful of events. The appropriation of so large a sum to the Fossil Department in the year 1877–8 has necessitated the avoidance of any extraordinary expenditure.

The first part of the tenth volume of the Transactions, together with the Sixty-fifth Annual Report, has been issued, and the ninth volume completed by the distribution of the index and table of contents.

It affords the Council satisfaction to receive from time to time proofs of the estimation in which the Transactions are held both at home and abroad.

The Museum appears to have lost none of its attractions for visitors. The following result of the examination of the pupils of the Science Classes affords satisfactory proof of the soundness of the instruction given; and it is gratifying to observe that four prizes for Theoretical and Practical Chemistry, offered by the Miners' Association for competition amongst pupils of affiliated classes, have been awarded to Mr. John A. Fox, Mr. W. H. Pellew, Mr. Edward C. Corin, and Mr. Arthur Triggs, members of the Classes instructed here by Mr. Barnett and Mr. Collins.

Mineralogy.

1st Elementary	4
2nd Elementary	3
Failures	0
	7

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Mineralogy.

1st Elementary	4
2nd Elementary	3
Failures	0
	7

Theoretical Chemistry.

Honours, failed	2
1st Advanced	4
2nd Advanced	1
Failed	1
1st Elementary	3
2nd Elementary	4
Failed	1
	16

Practical Chemistry.

1st Honours	1
2nd Honours	1
1st Advanced	2
2nd Advanced	3
Failed	1
1st Elementary	2
2nd Elementary	4
Failed	2
	16

A course of lectures on Geology, given by Mr. Collins, met, it is hoped, with sufficient success to induce him to continue his labours during the approaching winter.

In order to meet a long-felt requirement, the Council have appointed an Assistant Curator and Librarian, who will give regular daily attendance in the Museum. It is expected that the Society will derive much benefit from this appointment.

During the past twelve months two Honorary Members of the Society have died, Professor B. von Cotta and Mr. Sopwith.

It is proposed to elect Hofrath Baron Franz von Hauer, Director of the Geological Survey of Austro-Hungary, and Dr. Hans Bruno Geinitz, Professor of Geology and Mineralogy at Dresden, as Honorary Members.

The Council have also to deplore the loss of Sir R. R. Vyvyan, one of the oldest Members, of whose brilliant talents and varied accomplishments his native county was justly proud; of Mr. Samuel Higgs, who having acted for many years as Honorary Secretary with great advantage to the Society, proceeded to South

Australia to take charge of the Wallaroo Mines, and died from the effects of an accident in the prime of life; and of Mr. William Vivian, an Associate Member, who died at the Mwyndy Iron Mines in Glamorganshire, of which he had been appointed manager in 1860. The recent death of Captain Thomas Treweeke deprives the Society of another Associate Member. They also desire to express their regret at the long-continued indisposition of the Hon. Secretary, Mr. G. B. Millett, and trust that he may soon be restored to health.

The President having expressed a strong desire to be relieved from the duties of the office, in consequence of the additional labours imposed on him as Chairman of the Royal Commission on Accidents in Mines, the Council are of opinion that they will best mark their appreciation of the services he has rendered the Society by readily acceding to his wish, and beg to assure him that the Members will long retain a grateful recollection of his efforts to spread a knowledge of geological and mineralogical science, and promote the interests of this Society, during his eight years' tenure of office.

LIBRARIAN'S REPORT.

THE additions to the Library during the past year have been as follows:

I.—TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies and Editors, or Purchased.

American Academy of Arts and Sciences. Proceedings. Vol. v., new series, parts ii. and iii. Boston, 1878.

American Philosophical Society. Vol. xvii., No. 101. January to June, 1878. Vol. xviii., No. 102. July to December 1878.

American Philosophical Society's Library. Catalogue. Part iii. Philadelphia, 1878.

Bristol Naturalists' Society. Proceedings. New series, vol. ii., part ii. 1877–8. Bristol, 1878.

Cambridge University. Annual Report of the Library Syndicate to the Senate. 1879.

Connecticut Academy of Arts and Sciences. Vol. iii., part 2; vol. iv., part 1. New Haven, 1877–8.

Cornwall. Royal Cornwall Polytechnic Society. Forty-sixth Annual Report. Falmouth, 1878.

Cornwall. Royal Institution of Cornwall. Sixty-first Annual Report. Truro, 1878.

Edinburgh Geological Society. Transactions. Vol. iii., part ii. Edinburgh, 1879.

India. Geological Survey of India. Memoirs. Vol. xv., part i., and vol. xvi. Calcutta, 1878.

India. Geological Survey of India. Records. Vol. xi., parts 1 to 4, and vol. xii., part 1. Calcutta, 1878–9.

India. Geological Survey of India. Index. Vols. i. to x. inclusive. Calcutta, 1878.

India. Palæontologia Indica. Series iv., vol. i., part 3, and series xii., part 1. Calcutta, 1879.

Leicester Town Museum. Seventh Report of the Committee. Leicester, 1879.

London, Edinburgh, and Dublin Philosophical Magazine. Series 5, Vol. vii., Nos. 40–45. Vol. viii., Nos. 46–50, 1879. *Purchased.*

London. Geological Society. Quarterly Journal. Vol. xxxiv., parts 1, 2, 3. 1879.

London. Geological Society. Abstracts of the Proceedings. Nos. 369 to 373, inclusive.

London. Geologists' Association. Proceedings. Vol. vi., Nos. 1, 2, 3. 1879.

London. Palæontographical Society. Vol. xxxiii. 1879. *Purchased.*

Manchester Geological Society. Transactions. Vol. xv., parts vi., vii., and viii. Manchester, 1878.

New South Wales. Mines and Mineral Statistics of New South Wales. Sydney, 1875.

New South Wales. Royal Society of New South Wales. Journal and Proceedings. Vol. x. 1876. Sydney, 1877. Vol. xii. 1877. Sydney, 1878.

Paris. Annales des Mines. Vols. xv. and xvi. 1879.

Philadelphia. Academy of Natural Sciences of Philadelphia. Proceedings. Parts 1, 2, and 3. 1877. Parts 1, 2, 3. 1878.

Plymouth Institution, and Devon and Cornwall Natural History Society. Vol. vii., part 1. 1878–9. Plymouth, 1879.

Smithsonian Institution. Annual Report, 1877. Washington, 1878.

Smithsonian Institution, Miscellaneous Collections. Vols. xiii. xiv. xv. Washington, 1878.

United States. Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. iv., No. 3. Washington, 1878. Vol. v., No. 1. Washington, 1879.

United States. Catalogue of the Publications of the United States Geological and Geographical Survey of the Territories. Washington, 1879.

United States. First Annual Report of the United States Entomological Commission for the year 1877. Washington, 1878.

Victoria. Mineral Statistics of Victoria for the year 1878. Melbourne, 1879.

Victoria. Geological Survey of Victoria. Reports of Progress. No. iii., 1876; No. iv., 1877. No. v., 1878. Melbourne.

Victoria. Reports of the Mining Surveyors and Registrars of Victoria for the Quarters ending 30th September and 31st December, 1878; and 31st March and 30th June, 1879. Melbourne, 1878–9.

Victoria. Report of the Chief Inspector of Mines of Victoria for 1878. Melbourne, 1879.

Victoria. Royal Society of Victoria. Transactions and Proceedings. Vol. x., February, 1874; vol. xi., August, 1874; vol. xii., May, 1876. Melbourne.

II.—GEOLOGICAL AND MISCELLANEOUS BOOKS.

Presented by the Authors.

Clarke, Rev. W. B. Remarks on the Sedimentary Formations of New South Wales. Sydney, 1878.

Dunkin, E. Obituary Notices of Astronomers. London, 1879.

Ferguson, John. Address to the Graduates in Medicine at the University of Glasgow. Glasgow, 1878.

Ferguson, John. Address to Medical Students at the University of Glasgow. 1878.

Ferguson, John. Sir Humphry Davy (Reprinted from "Good Words"). 1879.

Foster, C. Le Neve. Report on the Inspection of Metalliferous Mines in Cornwall, Devonshire, Dorsetshire, and Somersetshire, for the year 1878.

Marsh, O. C. History and Methods of Palæontological Discovery. An Address. (Delivered August 28th, 1879.) New Haven.

Owen, Richard. On the Extinct Animals of the Colonies of Great Britain. London, 1879.

Pengelly, W. The Geology of the North-Eastern Coast of Paignton [July, 1878]. (From the Transactions of the Devonshire Association for the Advancement of Science.)

Pengelly, W. Remains of Whales found on the Coast of Devonshire. Part ii. [August, 1878]. (From the Transactions of the Devonshire Association for the Advancement of Science.)

Pengelly, W. Thirteenth and Fourteenth Reports of the Committee for Exploring Kent's Cavern. (Extracted from the British Association Reports for 1877 and 1878.)

Pengelly, W. The Literature of Kent's Cavern. Part iv. [July, 1878]. (From the Transactions of the Devonshire Association for the Advancement of Science.)

Robinson, Charles. The Progress and Resources of New South Wales. Sydney, 1877.

White, C. A., and H. Alleyne Nicholson. Bibliography of North American Invertebrate Palæontology. Washington, 1878.

Worth, R. N. The Bone Caves of the Plymouth District. (Reprinted from the Journal of the Plymouth Institution.) 1879.

CHARLES C. ROSS, *Hon. Librarian.*

PENZANCE, *Nov. 4th*, 1879.

CURATOR'S REPORT.

THE additions to the Museum during the past year have been as follows:

DONATIONS.

	NAME AND LOCALITY.	DONOR.
1.	Tin Ore, from an iron mine in the limestone formation, Campiglia Marittima, Tuscany	Richard Taylor.
2.	Fluor Spar and Quartz	"
3.	Ochre, Shotover Hill, Oxfordshire	W. W. Smyth.
4.	Tetrahedrite, Foxdale Mine, Isle of Man	"
5.	Malachite, Burra Burra Mine, South Australia	R. Dale.
6.	Bornite and Chalcopyrite	"
7.	Chessylite and Malachite	"
8.	Native Copper, Moonta Mine	"
9.	Bornite	"
10.	Bornite and Quartz	"
11.	Atacamite	"
12.	Copper Glance and Native Copper	"
13.	Peacock Copper Ore	"
14.	Copper Pyrites	"
15.	Cuprite and Native Copper	"
16.	Copper Glance	"
17.	Galena, North Hendre Mine, Flintshire	Goodman Ellis.
18.	Portion of the Lode, Van Mine, Montgomeryshire	William Williams.
19.	Zinc Blende, Van Mine, Montgomeryshire	"
20.	Slate, Van Mine, Montgomeryshire	C. Le Neve Foster.
21.	Staurolite, 12 miles east of Ducktown, Pennsylvania	"
22.	Atacamite, Wheal Cock, Botallack	S. H. James.
23–25.	Cupreous pyrites, showing slickensides, Rio Tinto Mines, Spain	C. Magniac.
26–37.	Cupreous pyrites and Copper Pyrites, Rio Tinto Mines, Spain	"
38–41.	Iron Ore, Rio Tinto Mines, Spain	"

NAME AND LOCALITY.	DONOR.
42–50. Specimens containing a mixture of Galena, Copper Pyrites, and Gangue, Rio Tinto Mines, Spain	C. Magniac.
51–57. Plumbiferous Cupreous Pyrites, Rio Tinto Mines, Spain	,,
58. Porphyry, Rio Tinto Mines, Spain . .	,,
59. Conglomerate, Rio Tinto Mines, Spain . .	,,
60. Native Copper, Rio Tinto Mines, Spain . .	,,
61–65. Agglomerated Cupreous Pyrites, containing Cupric Oxide	,,

PURCHASES.

1. Brown Hæmatite, Brendon Hills, Somersetshire.
2. Alabaster, Penarth, near Cardiff.
3. Gilbertite, Stenna Gwyn, St. Austell.
4. Blistered Copper Ore, Cornwall.
5. Amazon Stone, Pike's Peak, Colorado.
6. Fahlerz, Herodsfoot, Liskeard.
7. Galena, pseudomorphous after Pyromorphite, Germany.
8. Pharmacolite, Joachimsthal, Bohemia.
9. Chessylite, South Caradon Mine, Liskeard.
10. Stream Tin, Tregoss Moor.
11. Stream Tin, Tregoss Moor.

I regret that Mr. Barnett's professional engagements no longer admit of his acting as my assistant. I am very sorry to lose his services, but at the same time I must congratulate the Society on having resolved to appoint a paid assistant, whose business it will be to attend regularly at the Museum. There is a great deal of work remaining to be done, in the preparation of a proper catalogue and an extended guide to the collections. When these are published, the value of the Museum, both to students and the public generally, will be greatly increased.

C. LE NEVE FOSTER,
Honorary Curator.

PENZANCE, *November 3rd*, 1879.

TREASURER'S STATEMENT, 1878-79.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

RECEIPTS.

Nov. 1879.	£	s.	d.
To Balance	2	6	11
„ Donation per H.R.H. The Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears	80	12	6
	£102	19	5
To Balance	33	9	2

EXPENDITURE.

Nov., 1879.	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper, One Year and a Half	9	15	0
„ Insurance	2	12	9
„ Expenses per Secretary and Treasurer	5	19	2
„ Palæontographical Society	1	1	0
„ Grant in aid of Mr. Barnett's Class	5	0	0
„ Ditto Mr. Collins' Work on China Clay District	10	0	0
„ Books, Printing, and Stationery	23	9	8
„ Additions to Museum	2	5	0
„ Repairs, Painting, &c.	8	19	8
Balance forward	33	9	2
	£102	19	5

W. BOLITHO, JUN., *Treasurer.*

LIST OF PAPERS READ AT THE ANNUAL MEETING,

NOVEMBER 4th, 1879.

1. Notes on the Van Mine. By C. Le Neve Foster, B.A., D.Sc., F.G.S.

2. On the Geological Structure of the Northern part of the Meneage Peninsula. By J. H. Collins, F.G.S.

3. On the Recent Geology of the Cornish Coast near Padstow. By W. A. E. Ussher, F.G.S.

NOTES ON THE VAN MINE.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

Read 4th November, 1879.

The celebrated Van Mine,* the most productive lead mine in the British Isles, lies about 2½ miles N.N.W. of the town of Llanidloes, in Montgomeryshire. The surrounding country for a distance of some miles is composed of rocks of Lower Silurian age. In the immediate neighbourhood of the mine the strata consist principally of roughly-cleaved slates. Where clean and fresh sections of the rock can be observed, such as in quarries near the mine and on the road to Llanidloes, the distinction between the planes of bedding and those of cleavage can be seen very clearly. Near the mine I found the dip of the beds to be 35° in an E.S.E. direction, whilst the cleavage planes of the slate dipped from 45° to 60° W.N.W. Mr. Alfred Williams, however, tells me that the dip of the bedding is very irregular, and that there appears to be an anticlinal passing near the engine shaft.

I will first of all describe the lode, and then explain the manner in which it is worked.

* My colleague, Mr. T. F. Evans, and the Messrs. Williams, tell me that the name of the mine is derived from that of the mountain close by, called "y Fan." The meaning of this in Welsh is, "the place" or "the spot;" and the mountain was probably so named as it is the most prominent in the neighbourhood.

Theoretical Chemistry.

Honours, failed	2
1st Advanced	4
2nd Advanced	1
Failed	1
1st Elementary	3
2nd Elementary	4
Failed	1
	16

Practical Chemistry.

1st Honours	1
2nd Honours	1
1st Advanced	2
2nd Advanced	3
Failed	1
1st Elementary	2
2nd Elementary	4
Failed	2
	16

A course of lectures on Geology, given by Mr. Collins, met, it is hoped, with sufficient success to induce him to continue his labours during the approaching winter.

In order to meet a long-felt requirement, the Council have appointed an Assistant Curator and Librarian, who will give regular daily attendance in the Museum. It is expected that the Society will derive much benefit from this appointment.

During the past twelve months two Honorary Members of the Society have died, Professor B. von Cotta and Mr. Sopwith.

It is proposed to elect Hofrath Baron Franz von Hauer, Director of the Geological Survey of Austro-Hungary, and Dr. Hans Bruno Geinitz, Professor of Geology and Mineralogy at Dresden, as Honorary Members.

The Council have also to deplore the loss of Sir R. R. Vyvyan, one of the oldest Members, of whose brilliant talents and varied accomplishments his native county was justly proud; of Mr. Samuel Higgs, who having acted for many years as Honorary Secretary with great advantage to the Society, proceeded to South

TREASURER'S STATEMENT, 1878-79.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

RECEIPTS.

Nov. 1879.	£	s.	d.
To Balance	2	6	11
„ Donation per H.R.H. The Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears	80	12	6
	£102	19	5
To Balance	33	9	2

EXPENDITURE.

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„ Repairs, Painting, &c.	8	19	8
Balance forward	33	9	2
	£102	19	5

W. BOLITHO, JUN., *Treasurer.*

NAME AND LOCALITY.	DONOR.
42–50. Specimens containing a mixture of Galena, Copper Pyrites, and Gangue, Rio Tinto Mines, Spain	C. Magniac.
51–57. Plumbiferous Cupreous Pyrites, Rio Tinto Mines, Spain	"
58. Porphyry, Rio Tinto Mines, Spain . .	"
59. Conglomerate, Rio Tinto Mines, Spain . .	"
60. Native Copper, Rio Tinto Mines, Spain . .	"
61–65. Agglomerated Cupreous Pyrites, containing Cupric Oxide	"

PURCHASES.

1. Brown Hæmatite, Brendon Hills, Somersetshire.
2. Alabaster, Penarth, near Cardiff.
3. Gilbertite, Stenna Gwyn, St. Austell.
4. Blistered Copper Ore, Cornwall.
5. Amazon Stone, Pike's Peak, Colorado.
6. Fahlerz, Herodsfoot, Liskeard.
7. Galena, pseudomorphous after Pyromorphite, Germany.
8. Pharmacolite, Joachimsthal, Bohemia.
9. Chessylite, South Caradon Mine, Liskeard.
10. Stream Tin, Tregoss Moor.
11. Stream Tin, Tregoss Moor.

I regret that Mr. Barnett's professional engagements no longer admit of his acting as my assistant. I am very sorry to lose his services, but at the same time I must congratulate the Society on having resolved to appoint a paid assistant, whose business it will be to attend regularly at the Museum. There is a great deal of work remaining to be done, in the preparation of a proper catalogue and an extended guide to the collections. When these are published, the value of the Museum, both to students and the public generally, will be greatly increased.

C. LE NEVE FOSTER,
Honorary Curator.

PENZANCE, *November 3rd*, 1879.

TREASURER'S STATEMENT, 1878-79.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

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Nov. 1879.	£	s.	d.
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LIBRARIAN'S REPORT.

THE additions to the Library during the past year have been as follows:

I.—TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies and Editors, or Purchased.

American Academy of Arts and Sciences. Proceedings. Vol. v., new series, parts ii. and iii. Boston, 1878.

American Philosophical Society. Vol. xvii., No. 101. January to June, 1878. Vol. xviii., No. 102. July to December 1878.

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Cornwall. Royal Institution of Cornwall. Sixty-first Annual Report. Truro, 1878.

Edinburgh Geological Society. Transactions. Vol. iii., part ii. Edinburgh, 1879.

India. Geological Survey of India. Memoirs. Vol. xv., part i., and vol. xvi. Calcutta, 1878.

India. Geological Survey of India. Records. Vol. xi., parts 1 to 4, and vol. xii., part 1. Calcutta, 1878–9.

India. Geological Survey of India. Index. Vols. i. to x. inclusive. Calcutta, 1878.

India. Palæontologia Indica. Series iv., vol. i., part 3, and series xii., part 1. Calcutta, 1879.

Leicester Town Museum. Seventh Report of the Committee. Leicester, 1879.

London, Edinburgh, and Dublin Philosophical Magazine. Series 5, Vol. vii., Nos. 40–45. Vol. viii., Nos. 46–50, 1879. *Purchased.*

London. Geological Society. Quarterly Journal. Vol. xxxiv., parts 1, 2, 3. 1879.

London. Geological Society. Abstracts of the Proceedings. Nos. 369 to 373, inclusive.

London. Geologists' Association. Proceedings. Vol. vi., Nos. 1, 2, 3. 1879.

London. Palæontographical Society. Vol. xxxiii. 1879. *Purchased.*

Manchester Geological Society. Transactions. Vol. xv., parts vi., vii., and viii. Manchester, 1878.

New South Wales. Mines and Mineral Statistics of New South Wales. Sydney, 1875.

New South Wales. Royal Society of New South Wales. Journal and Proceedings. Vol. x. 1876. Sydney, 1877. Vol. xii. 1877. Sydney, 1878.

Paris. Annales des Mines. Vols. xv. and xvi. 1879.

Philadelphia. Academy of Natural Sciences of Philadelphia. Proceedings. Parts 1, 2, and 3. 1877. Parts 1, 2, 3. 1878.

Plymouth Institution, and Devon and Cornwall Natural History Society. Vol. vii., part 1. 1878–9. Plymouth, 1879.

Smithsonian Institution. Annual Report, 1877. Washington, 1878.

Smithsonian Institution, Miscellaneous Collections. Vols. xiii. xiv. xv. Washington, 1878.

United States. Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. iv., No. 3. Washington, 1878. Vol. v., No. 1. Washington, 1879.

United States. Catalogue of the Publications of the United States Geological and Geographical Survey of the Territories. Washington, 1879.

United States. First Annual Report of the United States Entomological Commission for the year 1877. Washington, 1878.

Victoria. Mineral Statistics of Victoria for the year 1878. Melbourne, 1879.

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II.—GEOLOGICAL AND MISCELLANEOUS BOOKS.

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Clarke, Rev. W. B. Remarks on the Sedimentary Formations of New South Wales. Sydney, 1878.

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fluor, tourmaline, and axinite; and the experiments point to the conclusion that, in many cases at least, the oxides of titanium, known to mineralogists as rutile, anatase, and brookite, have been carried and deposited in their natural localities by the instrumentality of fluorine. Again, the reaction of fluoride of silicon upon alumina was such as to produce a substance having most of the characters of topaz, another mineral found, somewhat sparingly it is true, in many of the tin-bearing localities, and amongst them at the Mount and at St. Agnes.

Investigations of a similar character have been carried out with brilliant success in the greater perfection of the products, by M. H. St. Claire Deville, M. Hautefeuille, and Messrs. Feil and Frémy. On the other hand, the highest of French authorities, M. Elie de Beaumont, pointedly referred to these conclusions of M. Daubrée's as being of signal importance in reasoning upon the origin of granite, and upon the effects which that most amply discussed of rocks has impressed upon the various stony substances with which it comes in contact.

Ladies and Gentlemen,—I have thus set before you in a very abbreviated form a sketch of the newer writings which affect some of the most prominent points in Cornish geology. Four times I have had the honour of receiving the suffrages which have placed me in the presidential chair; and now, at the end of eight years, it is no small satisfaction to look back over a tenure of office, rendered easy and pleasant by the unity of feeling which has actuated your Councils, and at the same time to entertain a confident opinion that in that period the Society has not become less useful than formerly. One final responsibility has devolved upon me, that of recommending to you a successor certain to uphold the character of the Institution; and I feel assured that in proposing as your future president a gentleman already connected with you by other ties, and one who has lately shown in print that he has not forgotten the lessons of Breithaupt and von Cotta—Mr. A. Pendarves Vivian—I shall act in accord with the wishes of all our members, and discharge with your full approval the last duty which devolves upon me before retiring from your chair.

REPORT OF THE COUNCIL.

THE Council beg to present this, the Sixty-sixth, Annual Report of the proceedings of the Society.

The past year has not been fruitful of events. The appropriation of so large a sum to the Fossil Department in the year 1877–8 has necessitated the avoidance of any extraordinary expenditure.

The first part of the tenth volume of the Transactions, together with the Sixty-fifth Annual Report, has been issued, and the ninth volume completed by the distribution of the index and table of contents.

It affords the Council satisfaction to receive from time to time proofs of the estimation in which the Transactions are held both at home and abroad.

The Museum appears to have lost none of its attractions for visitors. The following result of the examination of the pupils of the Science Classes affords satisfactory proof of the soundness of the instruction given; and it is gratifying to observe that four prizes for Theoretical and Practical Chemistry, offered by the Miners' Association for competition amongst pupils of affiliated classes, have been awarded to Mr. John A. Fox, Mr. W. H. Pellew, Mr. Edward C. Corin, and Mr. Arthur Triggs, members of the Classes instructed here by Mr. Barnett and Mr. Collins.

Mineralogy.

1st Elementary	4
2nd Elementary	3
Failures	0
	7

Theoretical Chemistry.

Honours, failed	2
1st Advanced	4
2nd Advanced	1
Failed	1
1st Elementary	3
2nd Elementary	4
Failed	1
	16

Practical Chemistry.

1st Honours	1
2nd Honours	1
1st Advanced	2
2nd Advanced	3
Failed	1
1st Elementary	2
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Failed	2
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liminary level, C the flucan, D the bastard lode, E the regular lode. (The only exception to this plan is at the 120 fathoms level, where the flucan has died out almost to nothing. In this case the preliminary level is driven in the bastard lode adjoining the regular lode.) Crosscuts F F (figs. 4 and 5, plate iii.) are now driven out north, about twenty or thirty fathoms apart, and from these the first *level in the lode* is pushed out east and west, as shown by the letter G. This level is driven on the main leader, and generally close to the footwall.

The next process consists in stripping away both sides of this *level in the lode* as far as the footwall on the north and the bastard lode on the south, unless the latter happens to be productive, and then it is stripped down also. At the same time the empty space is packed with *deads* derived from the flucan and from poor parts of the lode; and, if these do not suffice, further supplies are drawn from workings in dead ground at higher levels, or else from the surface, in a manner which will be described later on. A *working level* is reserved in the midst of the deads, and is properly secured with timber, as shown in fig. 6, plate iv. Round Norway timber, 8 to 10 in. in diameter, is generally used both for *forks* and *head-trees* (*legs* and *caps*, Cornwall), and the top of each leg is hollowed out a little to receive the cap. A *stretcher*, made of 2-inch plank nailed to the cap, prevents the legs from being forced inwards. A covering of small poles completes the timbering. This working level is generally built up about midway between the two

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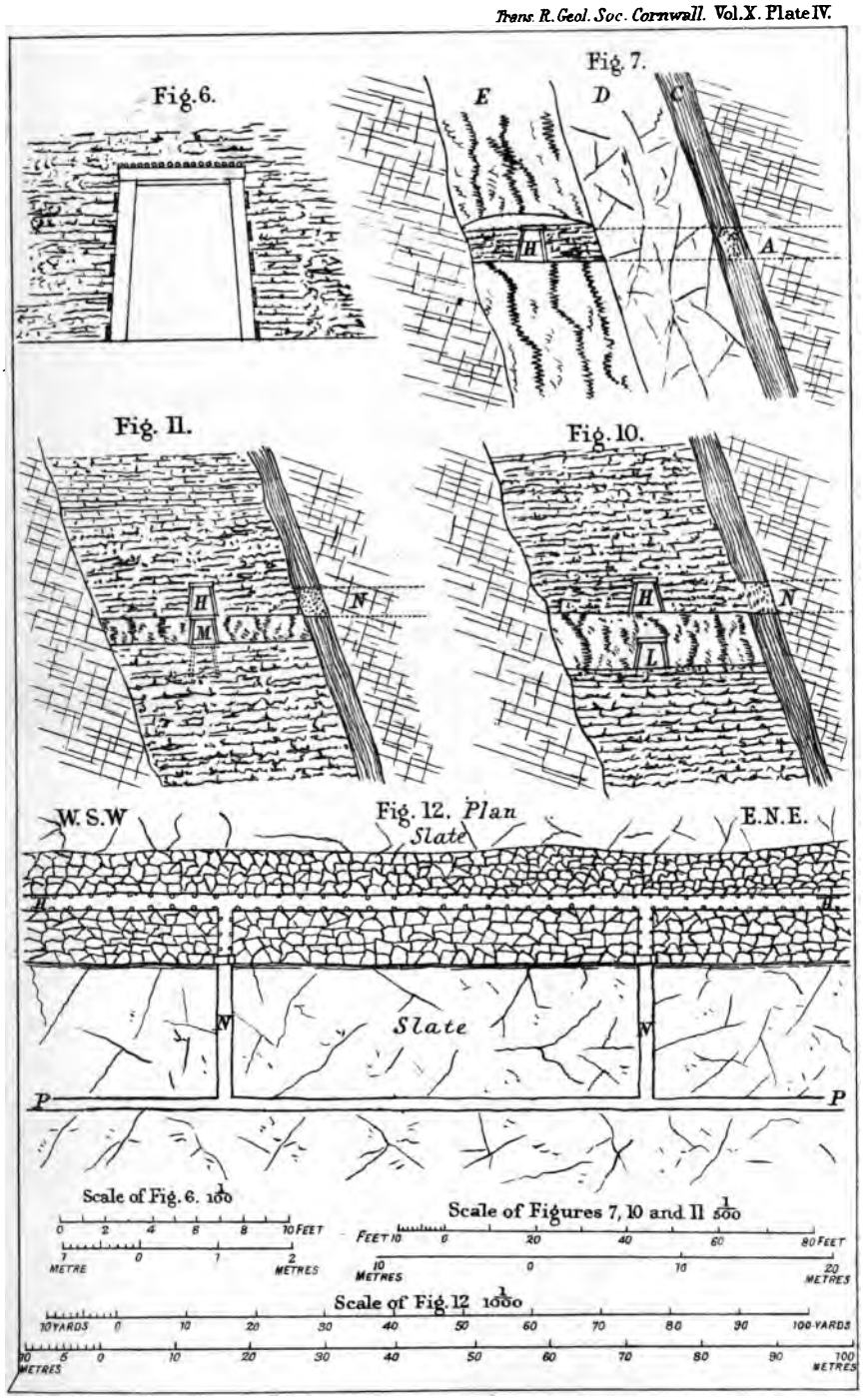


Fig. 6.
Fig. 7.
E
D
C
H
A
Fig. 11.
H
M
N
Fig. 10.
H
N
L
W.S.W
Fig. 12. Plan
Slate
E.N.E.
N
Slate
N
P
P
Scale of Fig. 6. 1/100
0 2 4 6 8 10 FEET
1 0 1 2 METRE METRES
Scale of Figures 7, 10 and 11 1/500
FEET 10 0 20 40 60 80 FEET
10 0 10 20 METRES METRES
Scale of Fig. 12 1/1000
10 YARDS 0 10 20 30 40 50 60 70 80 90 100 YARDS
10 5 0 10 20 30 40 50 60 70 80 90 100 METRES METRES

walls of the lode. Endeavours are always made to carry it as nearly straight as possible, so as to facilitate the tramming, and, consequently, if the lode makes a bend, it will either approach the footwall or hanging wall as the case may be. Fig. 7, plate iv., represents this third stage. Letters C, D, and E refer to the same parts of the lode as before, whilst H is the working level, provided with a proper tramroad of 2 feet gauge. The whole excavation has been filled up to within 18 inches of the roof or "back," save at one end, where it is proposed to begin the stoping. When the working level is completed, the level in the flucan is often abandoned; the timber is drawn out for use elsewhere, and the level allowed to crush together. In other cases parts of it are kept up, either for the purpose of conveying waste stuff for filling up, or to ensure proper ventilation through certain *winzes*.

In the meantime, starting from the level above, winzes are being sunk twenty or thirty fathoms apart in the flucan, or occasionally in the lode itself if the flucan is too far away from the productive part. These winzes serve not only for ventilation, but also as shoots for the rubbish used in filling up the excavations; they are usually called *passes*. This stage is shown in fig. 8, plate v., I being a pass. These winzes are made 6 feet by 3 feet within the timber, and then one side, 22 inches long, is separated by *dividings*, and the larger compartment closely cased up with 1½-inch plank. The small compartment then serves as a footway, and is also useful in case the larger one

should become choked with the rubbish. Large stones blocking the pass can then be removed without any danger to the men. P is a permanent level, and N a crosscut used for tramming in the deads, as will be explained later on. (See fig. 12, plate iv.)

As soon as the arrangements for supplying deads for filling up are completed, the stoping can be proceeded with. The ordinary length of each *bargain* or *pitch*, as we should say in Cornwall, is about 50 feet; and, in order to reduce the amount of wheeling, the bargains are arranged so that the men shall not be very far from the winzes from whence they obtain the *deads*. The height taken off by each stope varies according to the firmness of the lode from 2 feet to 6 feet, and as each stope is removed the excavation is carefully packed with rubbish, *mills* or *passes* being left, through which the ore is shot down for filling the trams. These ore passes are of the same size as the winzes, and are timbered in the same way. The lode itself furnishes enough poor rock to fill up perhaps one-third of the excavation. Some stuff is derived also from any workings in dead ground, such as from driving the crosscuts, or the preliminary or permanent levels; and, finally, slate is quarried at the surface, shot down special shafts, and trammed to the points where it is required.

In order not to lose any ore among the loose stones used for *stowing*, it is usual to spread over the top of the rubbish a layer of the soft flucan for a depth of a few inches, and when the lode has been stoped away to the required height, this floor is

Fig. 8.

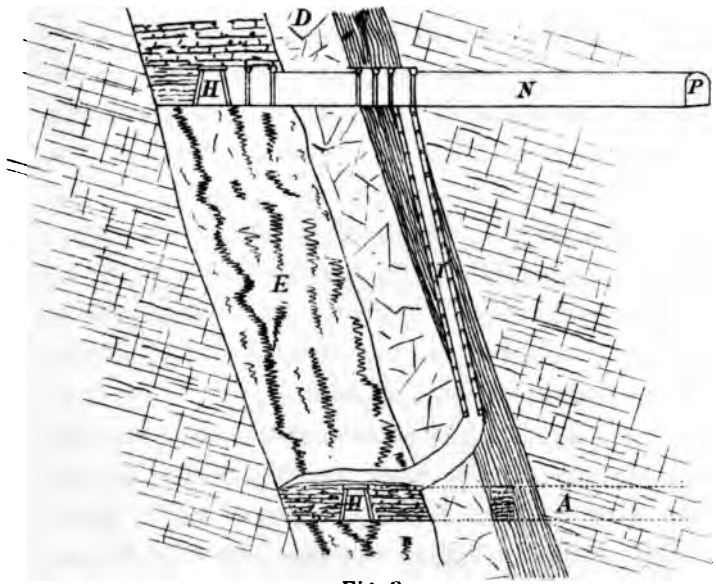
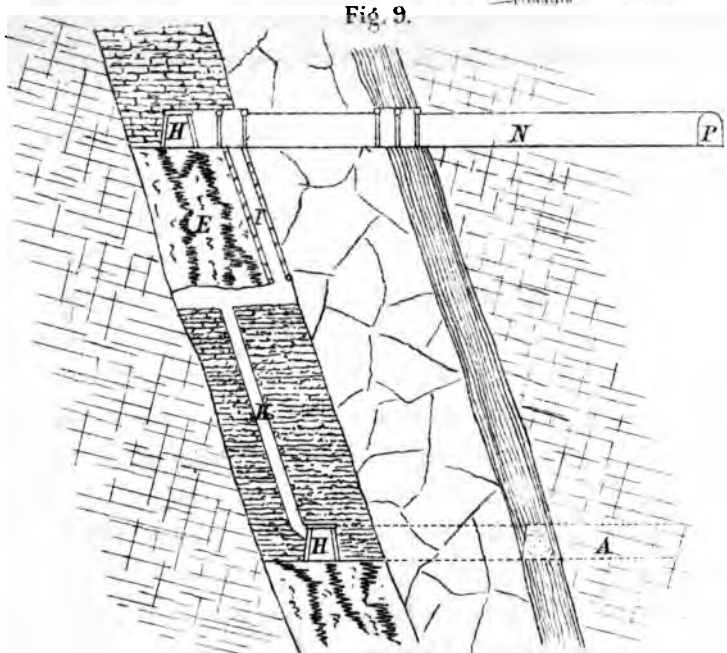


Fig. 9.



Scale $\frac{1}{500}$

FEET 10 5 0 20 40 60 80 100 FEET.

METRES 10 0 10 30 METRES

shovelled into the ore passes, and goes to be dressed with the rest of the stuff. It is found cheaper and better to dress a few tons of stuff extra than to go to the expense of laying down boards or sacking to catch the fine ore.

In fig. 9, plate v., using the same lettering as before, we have, in addition to the rubbish shoot (I), the built-up ore pass (K); and in this case, where the bastard lode is very wide, it has been found advisable to sink the winze in the lode itself.

The stoping proceeds in this manner till only 12 feet of lode remain below the workings of the level above. It is then thought undesirable to leave such wide openings as hitherto. The stopes are packed up tightly with rubbish, and a level is driven east and west along the strike in the middle of the lode, or on one side if more convenient, as shown in fig. 10, plate iv., H being the old working level, and L the new level in the lode. In this figure and the next the bastard lode is supposed to be productive, and hence everything is stoped away between the footwall and the flucan. As soon as the level L has been driven for a short distance, crosscuts from 5 to 8 feet wide are started from each side of it, and driven north and south to the footwall and hanging wall respectively, the ground being supported by strong props of timber. The lode standing on the sides of the crosscut is then removed by a series of cross drivages, similar to the original crosscut, only, as one side is free, the work is much less expensive, costing about £4 per fathom instead of £10. The

empty spaces are packed with rubbish to the top, and as much of the timber is drawn away as can be removed with safety.

When the lower half of the 12 feet slice has been thus taken away by a series of short contiguous cross drivages, another level M (fig. 11, plate iv.) is driven above the old one, which has been packed with rubbish. Crosscuts are started similar to the ones below, save that in driving under the deads the process of *spilling* has to be resorted to. While this work is proceeding the miners can recover any pieces of timber which were left in the midst of the rubbish used for stowing the lower half of the slice. The legs, or *forks*, are put in with the large end uppermost; by digging round the top a little room is made for fastening on a chain, and then the leg can be lifted out by means of a lever. As soon as the upper half of the slice has been taken off by these cross drivages the working level H is finally abandoned.

The block of lode fifteen fathoms high is thus removed entirely, and its place is filled by rubbish; consequently there is no danger of the walls falling in, and even during the progress of the work no high openings are made, any loose rocks can be taken down at once, and there is little danger of their falling unawares upon the miners.

During the progress of the stoping, the so-called *permanent level*, at the horizon of the bottom of the block, is being driven for the purpose of furnishing a road for conveying deads to the block beneath. Crosscuts N N, twenty or thirty fathoms apart, are

pushed out south for a distance of ten fathoms beyond the flucan, and *ends* are driven east and west till they meet and form a continuous gallery. (Figs. 8, 9, plate v., and fig. 12, plate iv.) A tramroad is laid down, and the level is ready for use. Several men are kept constantly employed at a quarry adjoining the mine in obtaining slate rock, which is trammed to and shot down one of the two rubbish shafts shown on fig. 2, plate ii. These can be tapped at the adit, and the supplies conveyed by tramroads and other special shafts used as shoots to the places where they are required. Save the first two rubbish shafts from the surface, no shoots are made more than fifteen fathoms long, because it has been found by experience that the timber becomes broken up very quickly by the fall of the stuff if longer ones are adopted. The bottom of one shoot is always near the mouth of the next, so that the rubbish never has to be trammed far; and in some instances the shoots are so near that, by fixing up a few sloping planks, the stuff runs directly from one into the other.

We have now followed the whole process of removing an entire block of lode fifteen fathoms in height, from the moment when the first level is driven in the flucan to the time when all the ore has been excavated, and its place taken by rubbish. There can be no doubt about the value of the system adopted by Captain Williams. With wide deposits in weak ground some filling up process is almost indispensable, unless an enormous expenditure is incurred for timbering, and even in much firmer ground I

cannot help thinking that the extra cost of filling up would frequently be compensated for by the increased protection afforded to the persons employed, and the additional security ensured to the mine itself as a property of permanent value. As a proof of the safety of this method of working, I may mention that my colleague's statistics show that there has been no fatal accident from a fall of ground since his appointment, nearly seven years ago, and that the non-fatal accidents from this cause have been few, although, on an average, 321 men have been regularly employed underground.

The amount of timber required in the present method of working is small, as many of the pieces are used over and over again. Another advantage is, that there is a certainty that no ore is left behind; for although money is sometimes spent in breaking down poor parts of the lode to make sure of not missing any lead ore, the stuff can be utilized for filling instead of drawing supplies from quarries at the surface.

I will now in a very few words follow the ore as it leaves the stopes. From passes such as K (fig. 9, plate v.) it falls into waggons, which are trammed to the shaft, raised in a cage to the surface, lowered down a self-acting incline, and tipped into a large shoot which feeds a Blake's stonebreaker. The broken ore is crushed by Cornish rolls till it will pass through a sieve with twelve holes to the square inch, and the crushed ore is carried by a stream of water on to a pyramidal separator. The slime which runs over is treated in spray buddles, whilst the coarser sand that

falls through goes to continuous jigging machines. These deliver clean lead ore fit for the market if necessary, or only requiring a slight washing on a flat buddle. In other words, a very large proportion of the lead is not touched by hand from the time it leaves the stopes till it is all but fit for the market. The jiggers also separate the blende.*

They treat monthly at the Van Mine about 5,000 tons of stuff, yielding about 500 tons of clean lead ore and 150 tons of blende.†

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* This is of course a very brief outline of the process; but I have reason to hope that ere long a full and complete description of the dressing operations at the Van Mine will be published. A memoir of this kind would be of much value.

† The following statistics concerning the Van Mine are derived from figures furnished to me by the Messrs. Williams, and Mr. W. J. Lavington, the Secretary of the Company, and from my colleague's Annual Reports.

Year.	Persons employed.		Lead ore sold.	Value of the Lead Ore delivered at Llanidloes or Caersws Station.			Blende sold.	Value of the Blende delivered at Llanidloes or Caersws Station.		
	under ground	above ground	Stat. tons.	£	s.	d.	Stat. tons.	£	s.	d.
1869	...	...	1,980	26,450	10	0	320	1,093	0	0
1870	...	...	4,770	62,142	0	0	550	1,692	10	0
1871	...	...	5,330	67,504	15	0	1,300	4,593	0	0
1872	...	...	5,790	84,023	17	0	2,000	6,423	5	0
1873	330	333	6,160	98,493	12	0	1,650	3,218	15	0
1874	358	303	5,600	79,170	2	6	2,050	4,090	0	0
1875	263	336	6,450	97,645	15	0	1,950	6,050	0	0
1876	297	328	6,850	102,925	0	0	2,460	9,633	7	6
1877	335	308	6,470	88,985	13	4	2,404	8,019	0	9
1878	346	272	5,800	64,590	0	0	2,100	5,759	7	6
Averages and totals.	321	313	55,200	771,931	4	10	16,784	50,572	5	9

During the last ten years, therefore, the Van Mine has produced 55,200 statute tons (56,085 metric tons) of lead ore, and 16,784 statute tons (17,053 metric tons) of blende. The lead ore contains on an average age about 81 per cent. of lead and 9 ounces of silver per statute ton (275½ grammes per metric ton). The blende contains about 55 per cent. of zinc. The chief proprietor of the surface and the mineral rights at the Van Mine

In conclusion, I must thank Captain W. Williams,* the manager of the mine, and his two sons, Messrs. W. Henry and Alfred Williams, for their valuable assistance, and for the information on all points which they so willingly afforded me; indeed, without their kind help it would have been impossible for me to have brought forward many of the details contained in this paper.

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is the Marquess of Londonderry, who receives a royalty of one-fourteenth of the value of all the argentiferous lead ore and blende sold by the Company.

The dividends paid during the ten years referred to in the table have reached the sum of £348,000; whilst the total amount of capital paid up by the shareholders since the Company was registered in January, 1869, has been only £4 5s. per share on 15,000 shares, or £63,750.

* With great regret I have to record the death of Capt. Williams, which took place on the 15th November.

ON THE

GEOLOGICAL STRUCTURE OF THE NORTHERN PART OF THE MENEAGE PENINSULA.

By J. H. Collins, F.G.S.

Read 4th November, 1879.

In a former paper* read to this Society I have described the geological structure of the country around Truro, and shown that it consists largely of Lower Silurian rocks, resting towards the north coast upon others of pre-Silurian age, and covered by a third series (there called the "Ladock Beds"), which are probably Upper Silurian. Since then I have been engaged in the investigation of the rocks in the neighbourhood of the Helford River, and especially of those lying to the south of the river, and which form the northern portion of the Meneage peninsula.† The tract of land in question is bounded southward by the belt of hornblendic and serpentinous rocks, which extends from Polurrian Cove past Claher Garden, Bochym, and Roscreage Beacon, to Dranna Point on the east coast.

* "Preliminary Note on the Stratigraphy of West Cornwall." *Trans. R. Geol. Soc. Cornwall*, vol. x. p. 5.

† The Meneage peninsula may be considered to include all the country lying south of the Helford River, and of a line joining Gweek Bridge with the Loe Bar.

The rocks to the north of the hornblendic belt appear to me to be, with two small exceptions, Lower Silurian. They are first seen on the west coast on the north side of the Polurrian rivulet, from which point, although they are much crumpled in places, and especially near Gunwalloe Church, they may be traced without the least difficulty around the coast, north-westward, to and beyond the Loe Bar. These rocks may be readily traced inland, except where interrupted by the Carn Menelez granite, by following the strike, past Gweek, to and beyond Falmouth Harbour, and so on to Gerrans Bay and Gorran; as long ago suggested by Peach, Couch, Whitley, and others, for the beds further to the east.*

In walking across the country from Helston to Porthalla, by way of Mawgan and St. Martins, the road lies almost entirely upon these same rocks, the strike being crossed for the first four miles nearly at right angles, and afterwards at an angle of nearly 60°. For the greater part of this distance—nearly 11 miles in all—the dip is to the S.S.E., averaging at least 30°, so giving a total thickness for these

* "The Curator reports that all the fossils of a Silurian character which are contained in the Museum have been taken from Gorran, and have been chiefly collected by Mr. Peach; but he adds that he has received specimens of rock, similar in character and general appearance, from Manaccan, to the south of the Nare Point, as well as from St. Breock in the north. The Council would therefore draw the attention of the Society to these localities, in the hope that some members would supply the necessary specimens from these spots."—*Trans. R. Geol. Soc. Cornwall*, vol. vii., Council Report, 1856.

"If the beds on the south of Mevagissey are (Lower) Silurian, so must be the quartz-rock and associated beds of Gerrans Bay, and also the quartz calcareous slate and conglomerates between Helford River and Porthalla."—N. Whitley, *Trans. R. Geol. Soc. Cornwall*, vol. vii. p. 336.

rocks of over 4½ miles. This vast thickness of strata exhibits no particular change of mineral character when the top is compared with the bottom, except perhaps that the upper beds are even more siliceous than the lower ones, that they are on the whole coarser in texture, and that they contain a few thin and irregular beds of highly siliceous black limestone. The rocks for the most part are gray siliceous schists, with a few beds of inferior blue roofing-slates, some soft sandy beds passing into a not very coarse conglomerate, and one or two beds of hard quartzite; these latter containing a few ill-preserved fossils. With the exception of the thin beds just mentioned, there is a total absence of limestones throughout the series.

Proceeding from Helston no quartzite is met with until the village of St. Martin is nearly reached. A little to the N.W. of this village it may be seen cropping out in the fields in huge masses in a line extending from Mudian and Henver to Bojorrow, a distance of nearly 3 miles. These masses have supplied the material for mending the roads of several parishes for many years. Most of the gate-posts in the neighbourhood are made of them, and parts of many hedges; but enough still remain *in situ* to mark the position of the bed.*

Continuing the route towards Porthalla no more quartzite is met with until the stream is crossed

* It is observable that rushes grow almost everywhere along the line of outcrop of these beds where the ground is at all flat, indicating an obstructed drainage at the junction of the quartzites with the other beds. This is noticeable also in the Gerrans and Gorran district.

which flows past Manaccan to Carne. Here the quartzite blocks again appear in the fields, and may be readily traced from near Trevaddra, one mile W.S.W. from Manaccan, to Carne. Still further on they are again met with near the foot of Roscreage Beacon, and may be traced from there in a N.N.E. direction to Penare Farm, where they appear as very prominent stacks of white rocks in the hill-side facing the sea.*

So far as I can make out there are three outcrops of the principal mass of quartzite, as shown in the accompanying sketch section, a, a', a'', figure 1, plate vi. The great quartzite and its associated beds dip S.S.E. in a line from Penare Farm to the foot of Roscreage Beacon (a''), and N.N.W. in a second line from Carne to Trevaddra (a'). Clear evidence of this anticlinal curve exists on the shore near the Nare Point. The quartzite is, I believe, the same bed which comes to the surface near the village of St. Martins. The Manaccan stream appears to flow for a considerable part of its course along the syncline.

* The blocks of quartzite lying at the surface have been indicated on the Government map by parallel dotted lines running nearly east and west, just as an elvan is marked. This band is not however coloured as an elvan, but left uncoloured in all the maps I have seen. The error in direction is easily to be accounted for. It is simply that the quartzite blocks occupy a much wider band of country than the bed from which they have been derived, and points have been joined on the map which do not really correspond. Although there is certainly no wide band or dyke of quartz, elvan, or other material running in the direction of this dotted line, it is not unlikely that there may be a fissure or lode in that position which has at some time supplied the silica for the silicification of the quartzites. It is only very locally that they appear to have been originally pure sandstones. Generally they have the appearance of highly-silicified "sandy killas," and I believe them to be permeable beds, which have been silicified along the line of strike.

Fig. 1.

Fig. 2.

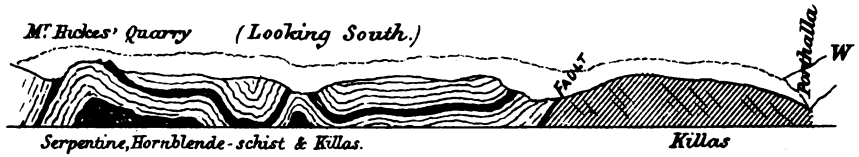

Fig. 3.

SKETCH MAP TO ILLUSTRATE COUNTRY AROUND PORTHALLA.

Trans. R. Geol. Soc. Cornwall. Vol X. Plate VI.

In company with Mr. Clark, of Truro, I have recently ascertained, what I always suspected, that these quartzites are fossiliferous. On the road from Porthalla to Manaccan we saw many piles of quartzite broken for the roads, which seemed most remarkably like the piles in the Gerrans district. Many obscure markings which appeared to have had an organic origin were seen, and at last Mr. Clark found a veritable cast of what looked like a Lower Silurian orthis. The search was continued, and two other somewhat similar specimens were found on other heaps by myself and my son respectively before we reached Manaccan. In sending some Cornish fossils to Mr. Davidson lately, I took the opportunity of enclosing these three specimens, merely saying that they were from a new locality. On the 25th October Mr. Davidson wrote me respecting them as follows: "The impressions on the quartzites belong to an *orthis* which I will endeavour to identify. Are they not Lower Silurian, like the quartzites found at Carn Gorran?"* This remark is valuable and independent testimony to the age of these rocks. We have not since found any other brachiopod remains, but several remarkable tubular cavities have been found at Bojorrow, near Manaccan, and in the stack of rocks facing the sea just east of Penare farmhouse. Similar cavities have been found in the quartzites of Gerrans Bay and Gorran.

* Mr. Davidson has since identified one as *Orthis testudinaria*, a well-known Caradoc species, and another as probably *O. Peachii*. Both these species occur in the Gerrans and Gorran District.

Nelly's Cove lies on the coast, about a quarter of a mile north of Porthalla Cove. Here the rocks dip steeply to the S.S.E., and consist of dark shales or slates with a few thin bands of black limestones. Near one of these I found the peculiar specimen, part of which I have placed on the table. It is evidently organic, but I have found no one yet who will venture an authoritative opinion as to its precise nature.

I searched for, but could not find, any of the orthoceratites similar to those which Mr. Peach found ten years since. Mr. Boase's specimen, No. 733, now in this room, and said to be from Porthalla Cove, was probably from the same place.* I can at least assert that it is not from Porthalla Cove.

These occurrences of organic remains of several types at or near the same spot must be regarded as important facts, and will, I think, help greatly to clear up the geological mystery of the district.

Proceeding along the coast eastward from Porthalla Cove to Dranna Point, a little over half a mile, the cliff section is the most remarkably instructive example of metamorphosed stratification to be found in the county. It has been referred to, and pretty accurately described in general terms, by Sedgwick†

* See President's Address for 1870. *Trans. R. Geol. Soc. Cornwall*, vol. ix., Fifty-seventh Annual Report, pp. 11, 12.

† "The small valley of Porthalla is excavated in some very soft ruinous beds. . . . Immediately beyond these crumbling masses we met with the first rocks of the serpentine formation, which extends along the base of the cliffs nearly as far as Dranna Point. They are difficult of access from above, but a boat may at any time be procured from Porthalla. In the whole of this formation we thought that we observed obscure indications of stratifica-

Henwood refers to the same section in similar terms,* and Dr. Budge says,† "The systems of hornblende and serpentine . . . . pass into each other by a transmutation so subtle as to defy all attempts at separation." He goes on to criticise De la Beche's very loose description of the same spot.

For about a third of a mile from the cove (*i.e.* up to Mr. Hickes's quarry) the cliff may be readily examined at low-water from the rocky beach (the section, figure 2, plate vi., represents this portion). It consists of much-contorted strata of slaty green and red serpentine and hornblende rock in numerous alternations, all, however, having a strike to the N.N.E. Beyond the quarry there is no beach, and the cliffs can only be examined by means of a boat, and then only in very calm weather. They appear to consist chiefly of slaty hornblende rock with a few bands of serpentine. I am now engaged in a microscopical and chemical investigation of the different beds composing this remarkable coast section, and I propose to describe them in a future paper. I may say, however, that I believe the whole series consists of highly-altered Lower Silurian stratified rocks.

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tion, and of a dip to a point between east and south-east which brought all the beds under the low-water mark near Dranna Point."—SEDGWICK, "On the Physical Structure of the Lizard District." *Trans. Camb. Phil. Soc.*, vol. i., 1822, pp. 297, 298. [The most interesting portion (*i.e.* that within a quarter of a mile of Porthalla) may be readily examined at low water by walking over the fallen masses. It is quite indispensable to do so indeed if the geologist wishes to form an accurate idea of the manner in which the serpentine alternates with the hornblende slate, both being contorted together. J. H. C.]

* *Trans. R. Geol. Soc. Cornwall*, vol. iv. p. 325.

† *Ibid.* vol. vi. p. 174.

The whole range of the Lower Silurian strata, extending from the Loe Bar to the Nare Head, is pretty much traversed by intrusive rocks; but I must defer all description of these rocks for the present.*

We now come to consider some small patches of rocks, which may be seen to overlie the rocks last described at several points. The best known of these is the often-described conglomerate of the Nare Point, which may be readily traced along the shore westward to Flushing and Carne. The low cliff at the Nare Point is composed of this conglomerate, which has a very regular east and west strike, and dips gently to the south, while the rocks exposed beneath it at low-water are nearly upright, the strike being N.N.E. East of this point they dip to the E.S.E.; westward, the dip is to the W.N.W. †

The conglomerate contains large masses of grey and white quartzite, rounded pieces of a still older conglomerate, and fragments of slate of various

* These consist of hornblendic rocks or diorites, dolerites, granite (so-called), felspar-porphyry (elvan), and mica-trap. This latter forms the well-known trap-dyke beneath Mawnan Church, referred to, but not described mineralogically, by De la Beche. I have found it in two places on the south side of the Helford River, cutting through the great conglomerate and the underlying Silurian rocks, and also near Navas Creek on the north side. In none of these places is it marked on the Government maps.

† This conglomerate is described by Budge (*Trans. R. Geol. Soc. Cornwall*, vol. vi. p. 1, *et seq.*); but many inaccuracies, arising from a too hasty survey, occur in his description, and he actually mistakes an elvan course which is cut through by the road just east of Manaccan for a portion of it. Even De la Beche (*Mem. Geol. Survey*, vol. i. p. 99) appears to take the trappean masses of the interior for the western continuation of this conglomerate. Here and elsewhere (*Rep. Corn., Dev., and W. Som.*, p. 95) he also seems to confound this conglomerate with the very much older one upon which it rests, as well as with that which occurs at the Nare Head in Veryan.

colours, some being composed of alternate dark and light bands.

De la Beche speaks of it somewhat doubtfully,* as containing pieces of hornblende rock, but no serpentine; and thence infers that it is newer than the first, but older than the second. I believe, however, that it contains no fragments of either rock; at any rate, I was quite unable to find any after a somewhat extended and minute search.

In places some of the included blocks of quartzite are of enormous size. Some, which I saw in fallen blocks on the shore east of Penare Farm and beneath the great stack of rocks already referred to (p. 50), must have weighed many tons. I have little doubt that they were originally derived from the Lower Silurian quartzite, as their mineral characters are identical, but no fossils whatever have been found in them as yet. Probably the Lower Silurians having been greatly denuded away, the harder portions then, as now, stood above the general level, and existed as islands in the sea in which the great conglomerate was laid down, this latter being formed of their ruins. Even now the geologically older rocks stand at the higher level.

The whole tract from the Nare Head to Porthalla is much faulted, and the quartzite hill on which Penare Farm stands, and which forms an anticlinal

* "Rounded pieces of the hornblende slate, though rare, are found in the conglomerate, while no trace has yet been discovered of either serpentine or diallage-rock, though the latter especially is of great hardness, and therefore quite as likely as the hornblende rock to resist comminution into fine sand." —De la Beche, *Report on Geology of Corn., Devon., and W. Som.*, p. 30.

axis, has probably been thrust up through the overlying conglomerate at many different points, or rather, this latter has sunk down on either side of it, so as to produce a similar change of relative level.

South of Penare Farm, and about a quarter of a mile north of Porthalla Cove, the conglomerate beds appear again, and are succeeded by some dark slaty beds which form the cliffs on both sides of the Cove. In those which bound the Cove on the north side there are many little oval brown bodies which appear like compressed trilobites, or rather like casts in cavities after such. They exhibit no structural markings on their surface by which they can be identified. Their mode of occurrence, however, and their regularity of form, indicate pretty clearly that they are of organic origin. I sent all my specimens to Mr. Davidson a week or two since. He reports that he cannot identify them.

Somewhat similar rocks appear in the low cliffs by the mill, on the right of the road leading from Porthalla to St. Keverne; but they are more compact, and appear to pass gradually into hornblende slate as they are followed to the south. East of this mill the same rocks may be traced on to Polkerris Point, and, I believe, they overlie the alternating beds of serpentine and hornblende slate already described as extending along the coast from Porthalla to Dranna point.

In conclusion I would draw attention to the fact that the result of these investigations—which have occupied a considerable part of several summers—is

to extend the area, to be marked in future as Lower Silurian on the Government maps, from St. Austell Bay to the Loe Bar, and from Porthalla to the neighbourhood of Redruth. I have little doubt that they will be found to continue still further, both to the east and to the west, and probably also to the north.

ON THE RECENT GEOLOGY OF THE CORNISH COAST NEAR PADSTOW.

By W. A. E. Ussher, F.G.S.

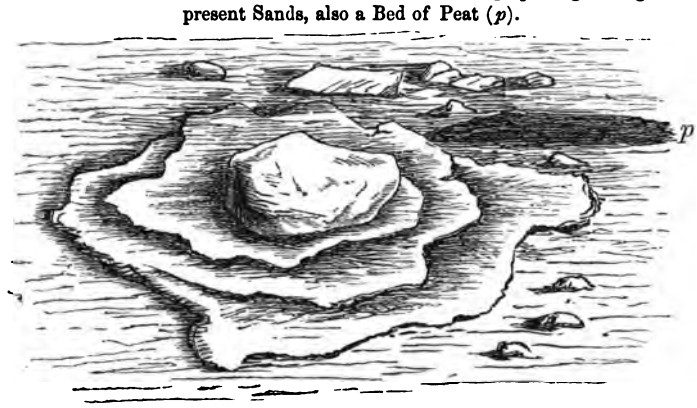
Read 4th November, 1879.

(ABSTRACT.) *

The author described two localities, which he considered of exceptional interest in the variety of deposits observable.

The first locality, Daymer Bay, Doombar Sands, in

Fig. 1. Doombar Sands.
Reef of Old Consolidated Beach with Quartz Boulder, projecting through the present Sands, also a Bed of Peat (*p*).



About $\frac{1}{20}$ of the natural size.

the Camel Estuary, furnished an excellent example of submerged forest, described seventeen years ago

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* This is an abstract of part of the pamphlet, "The Post-Tertiary Geology of Cornwall," by W. A. E. Ussher, printed for private circulation.

by Mr. Henwood, but now only represented by two or three spongy masses of peaty soil projecting through the sands. (Fig. 2.) Side by side with the peaty matter an old beach reef, consisting of consolidated buff laminated sandstone, enclosing pebbles, and quaquaversally dipping toward the base of a quartz boulder (fig. 1) embedded in the reef, was noticed breaking through the sands, at six feet below high-water mark, and at about seventy yards outward from the margin of the blown sands of the St. Enodock valley.

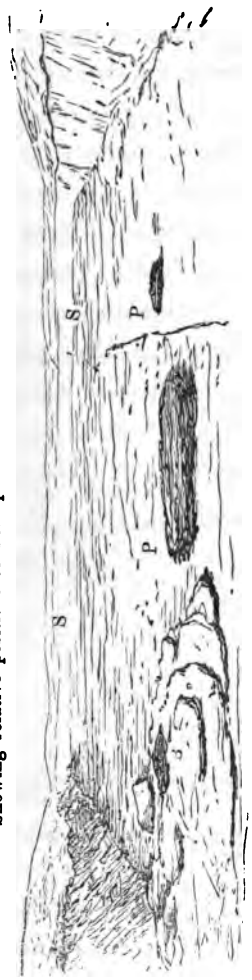


Fig. 2. Mouth of the St. Enodock Valley, Doombar Sands.
Showing relative positions of Peat patches and Old Consolidated Beach.

S S Sand Hills.
P P Peaty matter.
B Old Consolidated Beach.

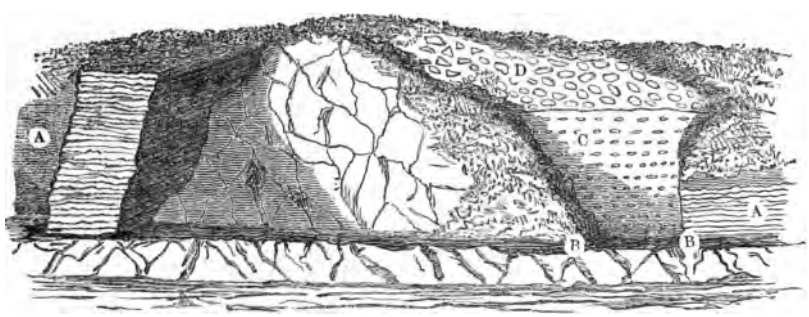
On the adjacent coast, near Trebetherick, traces of raised beach, at five to seven feet above high-water, were noticed.

The author considered that the raised beaches marked the culmination of a subsiding movement. The old beach below high-water mark he regarded as indicative of a pause in the succeeding movement of elevation, when sea and land occupied for a time similar relations to the pre-

sent level. The consolidation of the old beach he regarded as a proof of the continuance of the elevation of the land, and the submerged forest as a further proof, although he believed the forestial growth to have prevailed during a succeeding depression of the land, which finally resulted in the advance of the sea to its old cliff bounds and the destruction of the forest belts; as the period of precedent elevation, judging from the great surface waste, may have culminated in continental conditions, or at least produced a more rigorous climate than would have been conducive to the general spread of forest growth.

The author next described a section on Greenway Cliff, to the south of Hayle Bay. In this place a cliff, twenty-four feet in height, exhibited traces of

FIG. 3. GREENWAY CLIFF.
Vertical Scale—1 inch = 24 feet.



raised beach—fig. 3—(B B) adhering to a platform cut in the slates at about five feet above high water mark: On either side old consolidated blown sands (A A), dipping seawards at 20°, rested on the platform, and in one place abutted visibly against an exposed cliff face of slate. For fifteen feet upward from the

platform a red-brown loam full of slate fragments, generally angular (C), is exposed in one place. It is capped by four to five feet of gravel of well-worn and subangular grit, quartz, slate, and greenstone fragments (D). The relations of C and D to the cliff face of slate and the old blown sand, on either side of them, are obscured by grass growth and talus. They appear to occupy an eroded hollow in the slates.

The author regarded the old beach (B B) and blown sands (A A) as contemporaneous. The relations of the gravel (D) to the beach (B B) were then discussed. Four hypotheses were brought forward.

First. Regarding D as a raised beach older than B: rendered untenable by the entire absence of beach traces, or raised platforms, at corresponding heights in the district.

Second. Regarding D as a raised beach newer than B: negatived by the absence of a platform in the old blown sands at a corresponding height, and by the absence of all analogy for such an oscillation as this view would involve.

Third. Regarding D as fluviatile and older than B, it would then be the relic of an old drainage system, to which C might also be referred as an earlier fluviatile deposit. On this hypothesis the seaward continuation of C and D would have been truncated by the advance of the sea in cutting back the cliffs during the raised beach period.

Lastly. Regarding D as fluviatile and newer than the raised beach. On this hypothesis D might be taken as the deposit of a stream flowing seaward

through a channel cut in Head or old talus (C). But if, as is not improbable, C be also fluviatile, it is difficult to account for the position of the deposits on this hypothesis.

The author, therefore, inclined to the adoption of the third hypothesis; namely, regarding D as an old fluviatile deposit before the raised beach formation.

The author, in conclusion, drew particular attention to the fact that, if the stony loam C be regarded as an old talus or Head, it furnishes a notable and isolated exception to the rule laid down by Mr. Carne, as to the Head never being found beneath Boulder Gravels.

Royal Geological Society of Cornwall.

THE SIXTY-SEVENTH

ANNUAL REPORT,

ETC. ETC.

PENZANCE.
1880.

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Names of Honorary Members and Associates whose exact Addresses are unknown.

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Treloar, Thomas.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—In accordance with custom it devolves upon me now, as President of this old and much-respected Society, to make you a short address. Would that it had fallen into better hands; and most sincerely do I ask for your forbearance and patience.

The task comes to me—for more than one reason—harder than is otherwise might, succeeding in office as I do to so eminent and distinguished a geologist, and so practical and skilful an orator, as our late President, Mr. Warington Smyth. He had at his fingers' ends, so to speak, not only the science of Geology itself, which should to your Society be the basis of an address, but also was in a position to know from time to time the progress made both in its practice and theory. When he was kind enough to propose me for your favourable consideration as his successor, he told you that I had been a pupil of that great German geologist, Von Cotta. I am indeed proud of having studied under such an eminent man, as well as under Breithaupt, the mineralogist; Plattner, the great and early master of the blowpipe; Reich, the natural philosopher; and last, but not least, that most charming of any of the old geologists I ever came across, Professor Sedgwick, of Cambridge; but, ladies and gentlemen, I regret to say that these studies took place more than a quarter of a century ago, and other vocations and other matters have intervened, which have prevented me from keeping myself posted up as I ought to have done.

What wonderful progress is made nowadays in all sciences, more especially in the comparatively young—like Geology—in the course of a quarter of a century.

See how largely Palæontology and Palæobotany (this very word was not coined in my day I believe) have been developed and made use of for determining the particular geological epoch to which certain rocks belong! How changed the classification of certain strata, and how different the reasons assigned and accepted for certain geological phenomena! Since then, too, the blowpipe has become more used, and the microscope has been practically entirely introduced for investigating and determining the structure of rocks.

You will, I am sure, therefore, pardon me if my words are somewhat fewer, and if, too, they are not so purely technical as perhaps they should be when addressing this learned Society.

It is customary, I believe, in the first place to allude to those of our fellow-members who have passed away from amongst us during the past year. Though fewer in number than in some years, I regret to say that amongst them are the names of those who were not only well-known, loved, and respected in our own country, but who have left their mark in the world of science and commerce, and who may be looked upon not only as great local, but as great national losses.

Mr. John Michael Williams, of Caerhayes, has passed away, a true and staunch friend, and one who possessed to a large extent those virtues of perseverance and determination, which are perhaps more frequently met with in this part of the world than in any other. He was one of those who apparently met difficulties with a determination only of overcoming them, and never flinched from what he deemed to be the proper course.

It is satisfactory to know that his two sons promise to fill so well the positions they are placed in, and that they already take such a deep interest in scientific and commercial matters.

It is almost presumptuous for me to speak in this his own locality, and in the presence of so many of his closest personal friends, of the merits of, and of the great loss all have sustained in, Mr. Edward Rodd. I say *all* have sustained; for I look upon it that the loss is not confined to this his own particular neighbourhood, but is shared by the whole county, and indeed the scientific world generally. He was one of the best ornithologists of the day,

and had a charm of manner in communicating his knowledge which few could equal. My own friendship with him was of comparatively recent date, but short as it was it was sufficiently long to have an idea of how grievous must have been the blow to the large circle of his old and intimate friends, when he was suddenly removed from their midst. To me he appeared to be one of those invaluable characters, who, like the late Professor Sedgwick, of Cambridge, passed through life enjoying and appreciating scientific research into Nature's wonders, without allowing it however in any way to interfere with his belief and his duty towards his God and his neighbour.

We have to lament too the deaths of the Rev. Michael Nowell Peters, the vicar of Madron, one of the oldest supporters of our Society; and of Mr. John Jope Rogers, of Penrose.

With the latter gentleman I had not the honour of personal acquaintance, but from all I have heard of him his death may be placed amongst the most serious losses the county has sustained of late years.

I will now briefly allude to some of the contributions to our already fine collection which lie on the table before me.

On my left is a large number of carefully-assorted specimens, from our own county I believe, kindly given by our late curator, Dr. Foster.

Directly in my front, under the glass shade, is a beautiful specimen of Plumosite, or Feather Ore, sulphide of lead and antimony, presented by your late President, Mr. W. Smyth, who brought it from the Isle of Man. Its fine feathery crystals, under a microscope, present the appearance of a beautiful cobweb; but as a paper will be read on this rare mineral, written, I believe, by Mr. Smyth himself, I will say no more about it.

When in America a few years ago, I was lucky enough to secure some good specimens of Orthoclase, the Amazon Stone, which in old days was found, I believe, only in Russia, but just before I visited Colorado a large discovery had been made of it on one of the highest mountains of that State, over 12,000 feet above sea-level.

It gives me great pleasure to present your collection with one of the best specimens I obtained.

I have thought, too, that it might be of interest to students of Palæontology to see specimens of a somewhat peculiar fossil mussel, which has been recently found in one of our collieries in South Wales, about 220 fathoms from surface.

Curious to narrate that there are in that locality two collieries, within a mile or so of one another on the surface; the one sunk in the lowest series of the South Wales coal basin, is practically destitute of all fossil organic remains except the vein itself; the other, which is in the middle or Pennant series, abounds with many varieties of ferns, calamites, sigillariæ, lepidodendra, &c. They are working on different veins of coal, situated from 350 to 400 fathoms in vertical depth from one another, and it would seem as if in one instance the luxuriant tropical growth, which hereafter was to form the bed or vein of coal, had been all of a sudden overwhelmed with the muddy flood, whereas in the other case the flooding had been more gradual and quiet, thus giving a chance for some of the growth to float out and embed itself in the superincumbent mass of sand, mud, and clay.

These shells were found in the "*roof;*"—that is, the overlying part—of one of the finest veins of coal in the South Wales basin. Deeming that it might be of interest to you, I have had a sketch made of the section of this vein, affording as it does an excellent example of the usual concomitant of a vein of bituminous coal—the massive black diamonds of the nation. This Cribbor Vawr vein is one of the most important, and is the lowest of any great value in the South Wales basin. Below it are only two small veins, the Cribbor Fach, or Small Cribbor, and the Ffoes-y-fran, or Crow's-foot. Here we have the vein; the coal, composed as you well know of carbon, oxygen, and hydrogen, in differing quantities—in this case roughly about seventy-one per cent. coke or carbon, twenty-nine per cent. volatile matter (gases), one per cent. ashes or earthy matter—has been formed from the remains of the plants of sigillariæ and lepidodendra, and the many other tropical growths which luxuriated in our land in such an extraordinary manner during the

Carboniferous Period. These plants were in such numbers in the present instance as to afterwards form, under an enormous pressure, a dense mass of over nine feet of solid coal, and this thickness is often exceeded in other veins. These plants apparently grew in what is now a bed of "*fire-clay*," which is so porous and so anxious to absorb water as often to lift up the very railroad by the swelling or upheaving which consequently takes place. This is what is locally called "pucking," and is a source of great trouble and expense, as gangs of men have to be employed every night in cutting away the upheaving mass, or the "headings" would eventually get closed up.

Then above the coal comes a bed of black argillaceous shale, called locally "*cliff*," which contains a large amount of carbon, and in which are found the shells before us, and quantities of nodules of ironstone, something similar to the well-known "*black band.*"

Then after the flood had deposited this clayey mud to a depth to be compressed to three or four feet, it seems to have passed on and been succeeded by another flood, much richer in sand, from which was deposited a mass of sandy, irony mud. This afterwards formed a solid strata of dense, hard sandstone, called locally "rock," about a foot in thickness. Then above it again comes another bed or layer of argillaceous shale, and so on all through the strata of the coal basin, the different layers, whether they be of coal, fire-clay, shale, or sandstone, varying enormously in thickness, and often differing in appearance and chemical composition one from another. Sometimes what is locally termed a "*clod*" of clay occurs in the middle of the vein, as if the growth had been prematurely overwhelmed for a short period at that time; and when this occurs it is a source not only of great trouble to the miner, but of great depreciation in value to the owner, from the difficulty of keeping the coal clean from the clod, which on being burnt in the fire forms itself into ashes and clinkers.

I fear I may have troubled you somewhat long in this matter, but the contemplation of the formation of coal, and of the Carboniferous Period generally, is to me one of the most interesting epochs

in geological history. It is so curious too to think that this same land of ours, which was at the time of the Carboniferous Period subjected to the extreme heat of a tropical clime, as the fauna of this epoch clearly shows, was, in a later period, or perhaps periods, according to some of our best geologists, ice-bound and covered with its own systems of glaciers, and that, moreover, in the opinion of some astronomers, as stated in Professor Ramsay's learned and exhaustive address to the British Association, this year, the mountain tracts of Great Britain might again maintain their minor systems of glaciers, should the Arctic glacier ice ever extend in the same way as the ice does now northwards from the Antarctic continent.

If, then, I have tired your patience, and wearied you by dwelling thus long on this one period of Geology, I trust you will overlook it as an excess of enthusiasm for that epoch which I know best, and which I have been brought most in contact with of late years.

There are several papers of great interest, and some necessary business to be gone through and approved; I will therefore conclude what I fear must have been, though short, a very dull discourse.

I wish I had been able to give you a more learned and technical address, as your late President could have done, but I should have been unable to fill my part had I attempted this. I have therefore confined myself to matters which have come more under my own observation; and I can only thank you heartily, in conclusion, for your kind hearing.

REPORT OF THE COUNCIL.

In presenting their Sixty-seventh Annual Report, the Council have again the satisfaction of giving expression to their belief that the Royal Geological Society of Cornwall continues to advance in its career of usefulness, and in the beneficial development of its resources.

Your Museum, which with its recent additions in the Fossil-room, we have authority for saying, is one of the finest provincial Museums in the kingdom, is the frequent resort of the student and the passing visitor.

The Transactions have kept pace with the times, and find their way into every quarter of the globe. They are much in demand, selling readily at prices already advanced more than once, and in consequence of the repeated drain upon our store it will be again necessary to raise the price of certain volumes on account of their increased rarity.

It was at the last Annual Meeting that you decided upon securing the services of a paid Assistant Curator and Librarian. The Council cannot but congratulate the Society upon the success which has attended the experiment. Special attention during the last twelve months has been devoted to the Library, and, as will be more fully detailed by your Librarian, a large amount of work essential to its well-being has been undertaken and carried out, whilst some of the most important, viz., the preparation of the MS. for the press of a full and comprehensive Catalogue, approaches completion.

In the Museum comparatively little has been done, chiefly in consequence of the absence of your Curator, though the presentations to its cabinets are more numerous than usual. It was

with extreme regret that the Council received the resignation of your Curator, Dr. Clement Le Neve Foster, a resignation necessitated by his removal from the county, and in accepting it they desired to convey to him the expression of their thanks for the valuable services rendered to the Society during his tenure of office.*

The Guide to the Museum issued by Dr. Foster and Mr. Barnett having been entirely sold out, it has been reprinted; but it is hoped that one of the first undertakings of the new Curator will be to prepare a Guide upon a broader basis, as proposed by the authors of the present provisional pamphlet.

With sincere regret, too, the Council refer to the vacancies which death has caused in our roll. In the Rev. Michael Nowell Peters we have lost the oldest member, and a firm supporter of the Society. In Edward Hearle Rodd, a man who in his particular branch of study held a high place; but higher was the place he held in the esteem of all who knew him. Another lost to us is Mr. John Jope Rogers, of Penrose, whose kindly manner and useful literary work will cause him to be long remembered, no less by his neighbours than by the county at large. We have yet another death to record in Mr. John Michael Williams, of Carhayes, whose practical knowledge of mineralogy and devotion to the science caused him to be a valued member of this Society.

In conclusion, the Council beg to recommend the election of Professor N. Story-Maskelyne, M.P., and Dr. F. V. Hayden (of the United States Geological Survey), as Honorary Members; and the Rev. Sir Vyell Vyvyan, Bart., the Rev. H. S. Fagan, Mrs. Williams, of Carhayes, and Messrs. R. J. Frecheville, Henry Nicholas Harvey, Andrew K. Barnett, and W. Ambrose Taylor, as Ordinary Members of the Society.

GEORGE BOWN MILLETT,
Honorary Secretary.

PENZANCE, *November 5th, 1880.*

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* The Secretary would take this opportunity of recording his appreciation of the courtesy of Dr. Foster in editing the last issued Report and Transactions, a duty which would have devolved upon the Secretary had he not been absent from England in ill-health.

LIBRARIAN'S REPORT.

DURING the past year, thanks to Mr. Taylor, your Assistant-Librarian, much useful work has been accomplished in the Society's Library. The contents of the bookshelves have been completely overhauled, and partially placed in order. The Journals, Magazines, Pamphlets, and other publications, which have been accumulating during several years, have been carefully arranged. Over 250 volumes of scientific literature, comprising Transactions and Proceedings of learned Societies, Journals, Magazines, &c., have been collated, and are now ready for covers. In order that binding may be proceeded with it is very desirable that a grant of not less than £20 be made.

An additional number of nearly 100 volumes has been arranged so far as possible. An alphabetical list, showing missing parts, has been prepared, and applications have been made to Societies and individuals for the purpose of obtaining donations of the required parts. In the majority of cases such applications have been most courteously and generously responded to. The maps, diagrams, and sketches have been arranged and numbered, and a list of them entered in a book for convenient reference.

Mr. Taylor has also compiled what will no doubt prove a complete and useful Catalogue of the Society's Library. Its compilation has occupied considerable time and attention. The manuscript will shortly be ready for press.

The additions to the Library during the past year have been as follow:

I. TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies, Editors, and other Donors, or purchased.

Boston. American Academy of Arts and Sciences. Proceedings: New Series. Vol. vi.; vol. vii., part 1. Boston, 1879–80.

Columbus (Ohio). Proceedings of the Ninth Convention of American Instructors of the Deaf and Dumb, Columbus, Ohio. August 17–22, 1878. Columbus, 1879.

Cornwall. Report of the Explosives Committee, appointed jointly by the Royal Cornwall Polytechnic Society, the Miners' Association of Cornwall and Devon, and the Mining Institute of Cornwall. Edited by J. H. Collins. Truro, 1880.

Cornwall. Royal Institution of Cornwall. Journal: Nos. xxi., xxii. Sixty-second Report. Truro, 1879.

Also the following Journals and Reports received in exchange: Journals: No. iv.–xv. inclusive. Truro, 1865–74. Reports: 34th, 1852; 36th, 1854; 47th to 57th (1865–75) inclusive. Truro.

Cornwall. Miners' Association of Cornwall and Devon. Reports and Proceedings for 1871, 1876, 1878. Truro, 1872–79.

Cornwall. Royal Cornwall Polytechnic Society. Forty-seventh Annual Report, 1879. Falmouth.

Also the following Reports received in exchange: 7th, 1839; 15th, 1847; 22nd, 1854; 26th to 34th (1858–66) inclusive; 37th, 1869; 41st and 42nd, 1873–74. Falmouth.

Dorpat. Dorpater Naturforscher-Gesellschaft. Archiv für die Naturkunde Liv-Ehst-und Kurlands.

I. Serie.—Mineralogische Wissenschaften, nebst Chemie, Physik und Erdbeschreibung. Band viii., Heft 4.

II. Serie.—Biologische Naturkunde. Band viii., Heft 3. Dorpat, 1879.

Dorpat. Dorpater Naturforscher-Gesellschaft.

Sitzungsberichte. V. Band, Heft 1, 2. Dorpat, 1879.

Dublin. Royal Dublin Society. Proceedings: Vol. i., parts 1–3; vol. ii., parts 1–6. Transactions: Vol i., parts 1–12; vol. ii., parts 1, 2. Dublin, 1877–80.

Edinburgh. Geological Society. Transactions: Vol. iii., part 3. Edinburgh, 1880.

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„ 59–63, „ x., „ London, 1879–80. *Purchased.*

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Nos. 198, 199, vol. xxix.
„ 200–205 „ xxx.
„ 206 „ xxxi. London, 1879–80.

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Série vii., tome xvi., liv. 5, 6.
„ „ „ xvii., „ 1, 3. Paris, 1879–80.

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Plymouth Institution, and Devon and Cornwall Natural History Society. Publications: Vol. vii., part 2, 1879–80. Plymouth, 1880.

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[Presented by Dr. C. Le Neve Foster.]

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Fresh-water Rhizopods of North America. By Joseph Leidy. [Vol. xii., Reports in 4°] Washington, 1879.

Report on the Geology of the Henry Mountains. By G. K. Gilbert. Washington, 1877.

Victoria. Geological Survey. Prodromus of the Palæontology of Victoria. Decade vi. By T. McCoy. Melbourne, 1879.

Report of Progress. No. vi. By the Secretary for Mines. Melbourne, 1880.

Victoria. Mineral Statistics of Victoria, for the year 1879. Melbourne, 1880.

Report of the Chief Inspector of Mines to the Hon. the Minister of Mines, for the year 1879. Melbourne, 1880.

Reports of the Mining Surveyors and Registrars of Victoria, for the quarters ended 30th Sept. and 31st Dec., 1879; 31st Mar. and 30th June, 1880. Melbourne, 1879–80.

Vienna. K. K. Geologische Reichsanstalt. Verhandlungen: Nos. 1–11, 1880. Wien, 1880.

Washington. Smithsonian Institution. Annual Report, 1878. Contributions to Knowledge: Vol. xxii. Miscellaneous Collections: Vols. xvi., xvii. Washington, 1879–80.

II. GEOLOGICAL AND MISCELLANEOUS BOOKS.

Presented by the Authors.

Church, John A. The Heat of the Comstock Lode. [New York], 1880.

Collins, J. H. Western Chronicle of Science. Vol. i., No. 11. Falmouth, 1872.

Daubrée, A. Application de la Méthode Expérimentale à l'étude des Déformations et des Cassures Terrestres. Paris, 1879.

Delesse, Achille. Explosion d'acide carbonique dans une Mine de Houille. Paris, 1879.

Carte Agronomique du Départment de Seine-et-Marne. Paris, 1880.

Delesse et de Lapparent. Extraits de Géologie, pour les années 1877 et 1878. Paris, 1880.

Elliot, Sir Walter. Opening Address to the Botanical Society of Edinburgh, Nov. 10th, 1870. [Contains, as appendix, "List of Provincial Societies and Field Clubs in Great Britain and Ireland."]

Some account of the Plague of Field-mice in the Border Farms, in 1876–77, with observations on the genus Arvicola in general.

Millett, George Bown. Penzance, Past and Present. A Second Lecture delivered at the Penzance Institute, Mar. 25th, 1878. With a Plan of the centre of old Penzance, and other additional matter. Penzance, 1880.

Lindley, J., and Hutton, W. Illustrations of Fossil Plants. Edited by A. Lebour. London, 1877. *Purchased.*

ASSISTANT-CURATOR'S REPORT.

Owing to the amount of time occupied in the Library, I have been unable to give much attention to the Museum, so far as the collections are concerned. The Cornish fossils lent to Mr. T. Davidson have been duly returned, and many of the previously unnamed specimens have been named by that gentleman. The following letter was received:

"3, Leopold Road, Brighton, 15*th December*, 1879.

"Dear Sir,—I have this day forwarded by rail to you the box of Cornwall fossils, so kindly lent to me by the Council of the Royal Geological Society of Cornwall. I trust you will receive them all safe.

"The fossils have been of great use to me, and I have filled a quarto plate chiefly from the specimens now returned, and they will all be described in my *Silurian Supplement* now under preparation.

"I am, dear Sir, yours faithfully,

"Thos. Davidson.

"W. Ambrose Taylor, Esq., Museum, Penzance."

The Visitors' Book contains over 1,000 entries made since the last Annual Meeting, but this does not in any way represent the total number of visitors to the Museum, many of whom omit to enter their names, during the year.

The donations to the Society's collections are placed on the table.

I. MINERALS.

	NAME AND LOCALITY.	DONOR.
1.	Orthoclase (Amazon stone), Pike's Peak, Colorado, U.S.A.	A. P. Vivian.
2.	Pyrrhotine, with Copper Pyrites and Gold, from the lode at Clogau, Merionethshire	W. W. Smyth.

NAME AND LOCALITY.	DONOR.
3. Limonite, forming the Cement of a Breccia in the Perran Lode, Treamble	W. W. Smyth.
4. Molybdenite, South Kit Hill Mine, Callington [a new locality for this mineral]	"
5. Galena, crystallized on crust of Chalybite, with impressions of Fluor Cubes at back, Townshend Mine, Foxdale, Isle of Man	"
6. Plumosite (Feather Ore), or Heteromorphite, Old Foxdale Mine, Isle of Man	"
7. Tinder Ore, Clausthal, Harz	"
8. Kimmeridge Coal	C. Le Neve Foster.
9. Galena ("steel-grained") Tan-yr-allt Mine, Talybont, Cardiganshire	Captain C. Williams.
10. Calamine, Park Mine, Minera, Wrexham	Captain Bryan.
11–15. Atacamite, Arequipa, Peru	William Oats.
16. Chrysocolla, Arequipa, Peru	"
17. Chalcocite, Arequipa, Peru	"
18. Erubescite, with crystallized Pyrites, Arequipa, Peru	"
19–21. Specimens of the lode in the Cyfartha Silver-lead Mine, Llanbrynmair, Montgomeryshire	Capt. Josephus Nicholas.
22. So-called "Thunderbolt" (really a nodule of Iron Pyrites converted into hydrous oxide of iron), picked up near Chard	W. J. Hawker.

II. ROCKS.

1. Greenstone, Hennock, Devon	C. Le Neve Foster.
2. Schorl Rock, South Crofty Mine, Illogan	"
3. Schorl Rock, Lanner, Redruth	"
4. Epidote Rock, Withiel	"
5. Chiastolite Schist, Carleen, Breage	"
6. Chiastolite Slate, junction of Killas and Granite, Priest Cove, Cape Cornwall	"
7–11. Chiastolite Slate, Bosworgey.	"
12. Tourmaline Schist and Schorl Rock, junction of Killas and Granite, Cligga	"
13. Millstone Porphyry, Vale of Hlinik, Schemnitz, Hungary	"
14. Phonolite, Zittau, Saxony	"
15, 16. Amygdaloid, containing Crystals of Analcime, &c., Isle of Skye	W. Bolitho, jun.

III. FOSSILS.

NAME AND LOCALITY.	DONOR.
Fossil Shells, from the roof of the Cribbor Vawr Seam of Coal, South Wales Coal Basin . .	A. P. Vivian.
Fossil Fish, Purbeck Beds, Swanage . . .	C. Le Neve Foster.
Ceripora, Derbyshire	"
Graptolites, Penarth Slate Quarry, Corwen, Merionethshire	"
Bivalves, Limestone Quarries, Blackdown Hills, borders of Devon and Somerset . .	W. J. Hawker.
Favosites fibrosa (*Goldf.*), West-end of Lantivet Bay	C. W. Peach.
Protovirgularia dichrotoma (*McCoy*), Van Slate Quarry, Porthpean, Cornwall . . .	"
Scaphaspis Cornubicus [portion of] (*Lankester*), Lantivet Bay	"
Lingula [? distorta] (according to *Mr. T. Davidson. Mr. Peach* thinks it may possibly be L. squamiformis.) Pridmouth, near Menabilly, Cornwall	"
(?) Scales of Scaphaspis (*Lankester*), Fish Beds, Lantivet	"
Orthis calligramma (*Dalm*), Quartz Rock, Gorran Haven, Cornwall	"

IV. MISCELLANEOUS.

Boiler Incrustation, Minera Mines, Wrexham .	C. Le Neve Foster.
Section of Deer's Horn, cut from a deer's horn in possession of the Society, and mounted on glass for examination under the microscope . .	J. H. Collins.
Model of Mining Machinery (formerly the property of the late Wm. J. Henwood, F.R.S., &c.), from Brazil	J. B. Montgomery.

V. ILLUSTRATIONS OF MINERAL DEPOSITS.

1. Tin Ore, East Lovell Mine, Helston . .	C. Le Neve Foster.
2. 3. Tinstuff, East Lovell Mine, Helston . .	"
4. Tinstuff, with much Blende, East Lovell Mine, Helston	"
5. Tin Ore ("Capelly"), Wheal Prussia, Redruth	"
6. Tinstuff, Wheal Grenville . . .	"
7, 8. Tinstuff, South Wendron Mine .	"
9. " (North part of lode), South Wendron Mine	"
10. " (South part of lode), South Wendron Mine	"

NAME AND LOCALITY.	DONOR.
11. Tin Lode, Trumpet Consols, Wendron, Helston	C. Le Neve Foster.
12. Tin Vein in Granite, Trumpet Consols, Wendron, Helston	"
13. Tinstuff, South Lode, Lovell Mine, Helston	"
14. Tinstuff (rich), South Lode, Lovell Mine, Helston	"
15. Tin Ore, Wheal Prosper, Bodmin	"
16. Tinstuff, Balmynheer Mine	"
17. Tin Ore (a north lode), Providence Mine, Lelant	"
18. Tin Ore (a south lode), Providence Mine, Lelant	"
19. Tin Ore (carbona), Providence Mine, Lelant	"
20. Portion of so-called "Growan Lode," south branches, Providence Mine	"
21. Portion of Tin Lode, Wheal Jane, Kea, Truro	"
22. Portion of Brecciated Tin Lode, Wheal Jane, Kea, Truro	"
23–25. Portions of North and South Lodes, Trelyon Consols, St. Ives	"
26. Portion of "Flat Lode," showing Breccia of Capel cemented by Tin Ore, South Condurrow Mine, Camborne	"
27, 28. Portions of the lode, Minera Mine	"
29. Portion of lode, Snailbeach	"
30. Veins of Copper Pyrites penetrating Tinstuff, showing that copper is later than tin, Highburrow Lode, Carn Brea Mine, Illogan, Redruth	"
31. Galena, Fluor, Quartz, and Iron Pyrites, Tamar Valley Mine, Beerferris	"
32. Chalcedony, Blende, Galena, and Fluor, Tamar Valley Mine, Beerferris	"
33. Portion of "Flat Lode," intermediate level, between No. 2 and No. 3 levels, Val Toppa Mine. [Produce of Fine Gold per ton=1 oz. 16 dwts.]	"
34. Stanniferous Elvan, Belowda Hill.	"
35. Quartz Vein, with Greisen Walls in Granite, Cligga	"
36. Greisen and Granite, Cligga	"
37. Greisen, Carrigan Rock, St. Austell	"

NAME AND LOCALITY.	DONOR.
38, 39. Greisen, West Hawkmoor, Gunnislake .	C. Le Neve Foster.
40. Breccia, forming "country" of Manganese Deposit, Newton St. Cyres	"
41. Breccia (Triassic), forming hanging-wall of Manganese Deposit, Newton St. Cyres . .	"
42. Micaceous Sandstone (Carboniferous), found under Manganese Deposit, Newton St. Cyres .	"
43. Manganiferous Breccia, part of Manganese Deposit, Newton St. Cyres . . .	"
44. Killas, 80 cross-cut, near Perpendicular Shaft, Wheal Uny, Redruth . . .	"
45. Killas Breccia, coated with Quartz, Tinstone, and Chlorite, New Rosewarne Mine, Gwinear .	"
46. Grey "Hardwork" and Granite, Balleswidden, St. Just	"
47. Coarse Capel, Trelyon Consols, St. Ives . .	"
48. Capel, Chillaton Mine, Devonshire . .	"
49. So-called "Cab," between lode and granite, South Lode, Lovell Mine, Helston . . .	"

W. AMBROSE TAYLOR,
Assistant-Curator.

PENZANCE, *Nov. 5th*, 1880.

TREASURER'S STATEMENT, 1879-80.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

RECEIPTS.

	£	s.	d.
To Balance	33	9	2
„ Donation per H.R.H. the Prince of Wales	20	0	0
„ Life Members	21	0	0
„ Ordinary Subscriptions and Arrears	75	12	0
„ Sale of *Transactions*	7	17	6
	£157	18	8

EXPENDITURE.

	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper 6 10 0			
Less Rent, by way of acknowledgment, per Penzance Public Buildings Company 0 3 0			
	6	7	0
„ Assistant Curator	21	0	0
„ Sundry Bills	4	2	2
„ Expenses of Treasurer and Secretary	10	15	10
„ Printing, Books, and Stationery	31	4	6
„ Palæontographical Society	1	1	0
„ Insurance	2	12	9
„ Deposited at Interest	21	0	0
Balance forward	59	7	5
	£157	18	8

W. BOLITHO, Jun.,
Treasurer.

Nov. 5th, 1880.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

NOVEMBER 5th, 1880.

1. Pleistocene Notes on the Cornish Coast between Plymouth and Looe. By W. A. E. Ussher, F.G.S.

2. The Devonian Rocks between Plymouth and East Looe. By W. A. E. Ussher, F.G.S.

3. On the occurrence of Feather Ore (Plumosite) in Foxdale Mines, Isle of Man. By Warington Smyth, F.R.S.

4. On some new Pocket Pyrological Apparatus. By W. A. Taylor.

5. On Fossils from the Rocks of Cornwall, some of them new to the list. By C. W. Peach, A.L.S.

6. Note on the occurrence of Stanniferous Deer Horns in the Tin-gravels of Cornwall. By J. H. Collins, F.G.S.

7. Note on the supposed Serpentine of the Parish of St. Veep. By J. H. Collins, F.G.S.

8. Notes on the Geology of the South-east Border of Cornwall. By R. N. Worth, F.G.S.

9. Some particulars of the recent disaster at Naina Tal were also given by J. Hallet Batten, F.R.G.S.

PLEISTOCENE NOTES ON THE CORNISH COAST, BETWEEN PLYMOUTH AND LOOE.

By W. A. E. Ussher, F.G.S.

In offering the following notes on the recent geology of that part of the Cornish coast situated between Plymouth Sound and East Looe, to the Royal Geological Society of Cornwall, I feel that some apology is necessary for recurring to what may appear to be a well-worn theme, as the phenomena recorded throw no new light upon the recent geological history of the county.

My apology consists in the nature of the task I have undertaken; viz., to place on record such additional observations of the coast as it may be my good fortune to be enabled to make in districts not visited before, and to stimulate the researches of those whose opportunities as regards time and place are infinitely greater than mine, so that new facts may be massed together for the formation of more definite conclusions as to the nature and results of the recent geological vicissitudes experienced by the county.*

* With reference to the object last-mentioned, the Rev. F. C. Jackson, rector of Ruan, in the Lizard district, informed me, at your last annual meeting, that he had observed traces of a submerged forest on the foreshore in that locality, and I trust that the particulars may be communicated to the Society by the discoverer.

The following are the principal points of interest in the recent geology of the part of the coast described in this paper:

If we regard the sandy matter and occasional pebbles mixed up in the base of the Head, near Picklecombe Fort and Kingsand, at from 10 to 15 feet above high-water mark, as relics of Raised Beach, we have in them the greatest amount of elevation indicated, as the true examples of Raised Beach at Port Wrinkle, and between Millendreath and Looe, do not range more than from 2 to 7 feet above high-water mark, meaning of course the portions exposed. On the shores of Looe Island, and on the coast, near West Looe, the old beach platform is conspicuous.

The Head is best exhibited in the three following localities:

Between Kingsand and Picklecombe Fort, where its thickness is from 10 to 20 feet, and its red colour gives it a striking resemblance to unconsolidated Triassic Breccia.

In the cliffs near Rame Coastguard Station, on the north, 20 to 50 feet in height. Here the Head presents a stratified appearance through intercalated strips of light brown stoneless (or nearly so) loam.

In the cliffs between Downderry and Seaton, 20 to 40 feet in height, where the Head presents a similar appearance of stratification, and appears to mask an old beach platform. (*Vide Post Tertiary Geology of Cornwall*, printed for private circulation, W. A. E. Ussher, p. 43; and De la Beche, *Geological Manual*, p. 157.)

The cementing of the Head, near Downderry and Seaton, is worthy of note. The materials near its base would appear either to have been mixed with old beach sand during their accumulation, or to have been partially re-sorted with an admixture of sand from the present beach, and subsequently agglutinated by percolating water, possibly deriving calcareous matter from seams in the shales and slates (Middle Devonian) of the district.

A similar consolidation of Head in recent brown sandstone is visible in West Challacombe Bay, near Combe Martin, North Devon, where the agglutination of the sand seems to have resulted from the percolation of water down the cliff charged with carbonic acid, derived from the dissolution of calcareous matter in the lower beds of the great Middle Devonian slate series.

A little to the north of the words Raised Beach, engraved on the map, the cliffs are capped in places by Head, containing an admixture of brown sandy matter with small angular stones, and occasional pebbles, at about 15 feet above high-water mark.

For some chains westward from Picklecombe Fort there is a fine cliff section of Head, consisting of red loam, with angular fragments of slate and grit. At and near the base of the Head, from 10 to 15 feet above high-water mark, pebbles of red grit, some of large size, are apparently the relics of a Raised Beach.

At the mouth of the stream, on the south-west side of Mount Edgcumbe Park, the Head appears to be

an old stream gravel; it consists of 15 feet of red loam, with angular and slightly worn fragments of grit.

At about twelve chains west of the stream mouth traces of Raised Beach, buff and olive-green sand, are noticeable, partly masked by the overlying Head at 6 or 7 feet above high-water mark; at 30 yards further red-brown sand, with large pebbles of the subjacent grits, is visible at a little reef projection at from 10 to 12 feet above high-water. The cliffs above these traces of Raised Beach consist of red loam, with angular fragments of the local rocks. This Head resembles rubbly Triassic Breccia when seen from a distance, owing to its pronounced colour.

Near Kingsand, on the north, the igneous rock (Trap), shown on De la Beche's Geological Map, forms a spring-tide reef or platform; here and there, for about 10 feet above the reef, traces of Raised Beach, consisting of buff and red-brown sand, are visible under a Head of from 10 to 15 feet of red loam, with trap fragments.

At Cawsand Pier Cellars, a platform has been cut in the green slates at about 8 feet above high-water in one place, apparently supporting a Head of light brown and greenish loam, with angular slate fragments horizontally distributed throughout.

A Head of brownish and greenish loam, with angular fragments of slate, in places 20 feet thick, caps a part of the cliffs west of Penlee Point. The materials exhibit a slope seaward at the point.

The precipitous slopes descending on either side

from the summit ridge of Rame Head terminate in cliffs of grey slate, upon which no signs of Head or Raised Beach were observed.

North of Rame Coastguard Station the slates are cut into reef platforms, at about 3 feet above high-water; but no traces of Raised Beach are visible. The cliffs, 20 to 50 feet in height, for the most part consist of a Head of brown loam, with angular fragments of slate, shale, quartz, and grit, intersected in places by impersistent seams of light brown loam, giving the mass a stratified appearance. Toward its base the Head is sandy in places, either from association with sand blown from the beach, or from amalgamation with the relics of an old Raised Beach.

At Port Wrinkle traces of Raised Beach are visible at 2 to 5 feet above high-water, for about 200 yards, at the base of a cliff about 20 feet in height, and formed of a Head of angular slate fragments in buff and grey loam. The old beach is composed of well-worn pebbles of slate, quartz, and grit, for the most part small, and a few large subangular blocks of slaty grit, and occasional flint pebbles, cemented by blackish sand adhering to inequalities in a reef of grey slates. The beach is 18 inches thick in places.

The cliffs of Downderry are capped by a Head of brown stony loam for about half-a-mile. In the bed of the furthest of the two streams, east of Downderry, angular fragments are cemented in blackish sandy matter, forming a bed about a foot in thickness, probably an amalgamated trace of Raised Beach at the base of the Head. At about a quarter of a mile east

of Seaton, the Head is cemented in one spot at about 2 feet above high-water.

Between Downderry and Seaton the cliffs are from 20 to 40 feet in height. The Head is composed of angular slate, quartz, and slaty grit stones, in brown and greyish loam, frequently presenting a stratified appearance through associated stoneless strips of light brown loam. It appears to mask an old beach platform, which is exposed in one or two places at about 5 feet above high-water mark; very occasionally isolated pebbles are observable on the platform.

The mouth of the valley at Seaton is dammed by a bar of coarse sand and fine shingle, rising to from 3 to 4 feet above high-water.

On the east side of the stream on Millendreath Beach, a bank 6 feet in height presents the following section:

Grey and brown vegetable soil, upon stream gravel, pebbles, and subangular fragments, in brownish sandy loam. The gravelly part is uppermost, and about 6 inches in thickness, the lower part of the bed being 2 feet, upon brown stony loam—a comparatively recent Head or talus.

No traces of the submarine forest were observable on the occasion of my visit.

At about half way between Millendreath Beach and East Looe a trace of Raised Beach was noticed, consisting of pebbles in semi-consolidated sand. Near this the following observations were made:

In one place the Raised Beach consists of a bed of coarse blackish sand, or fine gravel of well-worn

quartz and slate fragments, with occasional fair-sized pebbles and subangular fragments, resting on an inequality in a rock platform at from 6 to 7 feet above high-water. The upper part of the beach is a dull grey semi-consolidated sand rock. In another spot the beach is represented by about a foot of rather coarse gravel, of pebbles and subangular fragments of grit, slate, and quartz, in blackish sand, under sand 6 inches to 1 foot in thickness.

Near this the gravelly part of the beach attains to 2 feet in thickness, the sandy stratum being from 1 to 2 feet thick, and the base of the beach about 4 feet above high-water.

Further east the gravel and coarse sand of the Raised Beach form a stratum 2 feet thick, at the base of the cliffs, at about 3 feet above high-water.

The Head overlying the Raised Beach is composed of yellowish-brown loam, with small shale and slate fragments, with an appearance of linear distribution in bands.

On the south of the river Looe, opposite Chimney Rock, the Raised Beach platform is visible, but the locality was not visited.

The shores of Looe Island seem to form an outlier of the old beach platform.

THE DEVONIAN ROCKS BETWEEN PLYMOUTH AND EAST LOOE.

By. W. A. E. Ussher, F.G.S.

The main mass of the great Plymouth and Torquay limestone terminates in the north part of Mount Edgcumbe Park, being faulted on the west against shales with strings of decomposed calcareous matter, having a similar dip; and on the south dipping S. 5° E., at 60° under similar shales, associated in places with ashy matter.

Near its junction, north of Barnpool, the coralline limestone contains in one place masses of hard red sandstone, either proving the existence of local impurities during the growth of the reef, or resulting from subsequent chemical changes.

Near Churston Cove and Fishcombe Point, Brixham, South Devon, the limestone is intersected by dykes and veins of red sandstone in places, which, being themselves intersected in places by string cores of limestone, suggest chemical metamorphosis.

South of the limestone, by Barnpool, slates and shales, with occasional nodular films of calcareous matter, dip S. 7° E. at 45°, intersected by a dyke of slaty greenstone running N. 30° W.; they also contain an apparently interbedded mass of igneous rock.

Further on the shales appear to be contorted at a fault, bringing up a dyke of igneous rock running W. 15° N., and separating them from a series of shales containing bands, seams, and lenticular strings of limestone, with a general dip S. 5° W. at 25°.

Toward Picklecombe Fort the evidence is confined to beach reefs (the low cliffs being either masked by Head or undergrowth). In these we encounter bluish-grey shales intercalated with grey grits, succeeded by red grits, and slaty grits with occasional shaly beds, intersected by two dykes of igneous rock. The grits appear to dip northward at a low angle. West of Picklecombe Fort red and lilac grits, apparently intersected by a fault in one place, and by an igneous dyke in another, form the beach reefs.

Near the south-west corner of Mount Edgecumbe Park, lilac, grey, and reddish shaly grits, nearly vertical, strike east and west. For about ten chains westward from the above the grits undulate at low angles. In one place an impersistent brecciated seam was observed. We next obtain a dip of 25° to the west, and at about three chains further on a S. 20° W. dip of 45°. Near this the reefs consist of nearly horizontal beds of lilac-brown grits, intersected by filaments of quartz, and are also exposed under the Head in the cliff. Further on the grits are very evenly bedded, and dip S. 20° W. at 45°. At about eight chains from the last observation, and half-a-mile from Kingsand, the Devonian reefs terminate near a small exposure of Triassic Breccia, dipping under the Trap rock of Cawsand, or more properly

of Kingsand, Cellars. Here the reefs consist of red and lilac-brown grits, intersected by filaments of quartz, dipping S. 40° W., under gritty quartziferous shales and grits, banded with grey and chocolate-brown tints.

At Maker Barracks a dip of 50° S.W. was obtained in beds apparently belonging to the grit series. By the high road, north of the barracks, red and grey grits dip E. 15° S. at from 10° to 15°. With the exception of a grit-bed in green and lilac slates, exposed in the lane from Millbrook to Trewinnow, there is not the slightest appearance of a prolongation westward of the grits as a series; their discordant dips would appear to indicate a Pre-Triassic fault boundary, between Maker Barracks and Millbrook, whilst near Picklecombe Fort their junction with the calcareous shales may be either unconformable or effected by fault, as far as the evidence goes. These beds are evidently a continuation of the Staddon grits on the opposite side of Plymouth Sound. The cliffs above Staddon Pier are formed of massive red grits, intersected by irregular joints, and dipping to the south at about 40°. The grits are probably cut off by fault near Withy Hedge against reddish and grey shales, partly calcareous, and resting upon grey and dark bluish grey shales overlying the limestones of Mount Batten, Hooe, and Oreston.

I shall have occasion to revert to the position of this grit series after the conclusion of the following detailed notes on the beds exhibited in the cliff-line between Cawsand and Looe.

The junction between the grits and slates has no effect on the boundary of the Trap rock, and, if a fault, is therefore Pre-Triassic; greenish and buff slates, near Coombe (N.N.W. of Kingsand) dip S. by E. at 15°, the cleavage inclining at 55°.

South of the Trap mass reefs of buff and greenish shale, or slates, crop out on Cawsand Beach.

At Cawsand Pier Cellars pale green shales, or slates, with quartz veins interlaminated in places, appear to dip S. 28° W. at about 80°, the dip of the cleavage, there being no other indication of bedding. At seven chains further south, green slates with vertical cleavage planes appear to dip in a similar direction at 60°.

Penlee Point is formed of pale greenish and grey shales, or slates, with quartz irregularly associated, partly gritty, apparently dipping S. 20° W. at 80°, and in places vertical. But it is possible that the true dip is unascertainable, as two impersistent cracks in the rocks at the Point would, if signs of undeveloped bedding planes, afford a southerly dip of about 40°.

At about thirty chains west of Penlee Point the cleavage planes dip N.E. at from 70° to 80°; and at a quarter of a mile further west they dip N. 10° W. at 75°. Being apparently coincident with the bedding, these sharp dips indicate a sharp synclinal, striking with the coast-line, and counteracted by an anticlinal at about thirty chains south-west of Rame Church.

Rame Head is composed of grey slates, with interstratified beds of grey quartz-veined fine grit, to which it probably owes its prominence. The strike

of the beds alters to W.N.W. on the western cliffs of the promontory.

North of Rame Coastguard Station the quartz-veined greenish shales and slates are interstratified with masses of lilac shale and slate, and contain occasional beds of grit. They dip S. 20° W. at 35° to 40°. The cleavage planes incline at 50° W. of Trehill, the slates dip S.E. at 20° W. of Wiggle, slaty grits are interstratified, the dip being south.

West of Trewinnow, greenish shales, slates, and gritty beds contain beds of hard grey quartz-veined grit dipping S. 10° W. at 10°.

At the cliff path from Treganhawke, lilac, grey, and greenish slates, shales, and gritty beds dip S.S.E. at 20°. The passage between shales and slates is most irregular, and the laminæ are frequently in wavy lines.

Near the bend in the lane, south of Withnoe, lilac and greenish slates, with occasional beds of quartz-veined grit, dip S. at 30°. The cleavage planes dip southward at 50°.

Near the stream mouth, west of Withnoe, a thin greenstone dyke is visible in the greenish and lilac slates. At about a quarter of a mile further west the slates appear to be intersected by a nearly east and west fault; further on they contain quartz veins and gritty beds, and dip S.E. at 55°.

South of Lower Tregantle, a fort (not shown on the Ordnance Map) overlooks the coast. The cliffs to the south of it are composed of reddish and grey parti-coloured shales, containing beds of grit and sandy

films with markings resembling annelid tracks. These beds dip E. 18° S. at from 30° to 40°. By them we are introduced to a less homogeneous series of beds than those we have hitherto been considering since quitting Cawsand.

The following descending sequence is presented by them:

1. Even shales and shaly grits, weathering buff and reddish, and passing downward into—

2. A series of shaly sandstones, of pale buff and yellowish tints, with irregular concretionary bands of brown iron ore (limonite), and containing occasional brown beds (decomposed limestone), and traces of crinoidal limestone. The dip is regular, E. 20° S. at 30°. The friable character of the sandstone is evidenced by the fine beach sand piled up against the base of the cliffs. *Asplenium Marinum* abounds on this part of the coast. The sandstone series passes downward into—

3. Dark bluish-grey, quartz-veined, calcareous shales, resting upon slates weathered buff, and dipping in an E.S.E. direction at 20°, the cleavage planes inclining at 60°. The slates, with a brown fossiliferous bed (decomposed limestone), appear to be cut off by fault against very fossiliferous calcareous shales dipping in a south-easterly direction at from 30° to 40°. The calcareous matter is so decomposed that the fossils are scarcely identifiable, but films of undecomposed limestone are visible in places. These beds are succeeded by slaty crinoidal limestone superficially red-stained, and intersected by calc spar veins.

The cleavage planes dip S.E. at 45°. The bedding planes are disposed in a gentle synclinal. Further on grey and reddish calcareous shales, with occasional beds of limestone, dip S.E. at from 10° to 30°. These calcareous beds overlie—

4. Whitish, even-bedded, gritty slates, with even beds of sandstone, dipping in a S.E. direction at an angle of 30°. The cleavage of the slates inclines at 70°. The sandstones contain brown ferruginous matter, as in the beds (2) above the calcareous strata.

Below the above distinguishable sequence the succession of the strata may be gleaned from the following observations:

South of Crafthole, yellowish and buff shales and slates appear to rest upon grey slates, partly gritty, dipping S. 15° E.

East of Port Wrinkle, at the lane to Crafthole, rather dark grey quartz-veined slates and shales seem to be faulted against greenish and lilac slates and slaty beds apparently contorted.

In the little bay east of Longstone, grey slates associated with slaty grits dip S.E. at 55°. On the west of Longstone similar beds dip E.S.E. at 30°, the cleavage planes inclining at 65°.

Near Downderry, grey slates with beds of grey grit dip in an E.S.E. direction at 15°, the cleavage inclining at 45°. On the west of Downderry, green and indian-red quartziferous slates and slaty grits appear to be contorted.

At Seaton the slates contain beds of grey quartz-veined grit, dipping about E. 15° S at 30°.

On the opposite side of the Seaton Valley similar beds dip from E. to E. 15° S., at from 20° to 25°. These beds seem to rest upon dark bluish-grey shales, striking with the general trend of the coast, and dipping in a southerly direction at 45°. Near Millendreath (Millendrāth), the dark shales overlie grey, buff, and reddish shales and gritty slates, dipping southward at 40°.

Between Millendreath and East Looe; for five chains from the Millendreath valley, grey shales resting on buff gritty beds dip S.E. at 45°. At this point grits are exposed dipping under dark bluish shale, with patches and thin strings of quartz. Their dip is S. 30° E. at 40°.

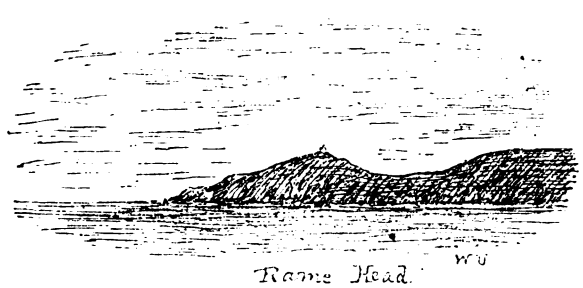
At four chains further on, pale buff, lilac, and yellowish, rather evenly-bedded shaly grits are exposed. At about thirteen chains from the Millendreath stream, the road to Looe crosses a spit of beach-sand. At eight chains further on, grey shaly grits, and even-bedded shales with much quartz, dip S. 23° E. at 45°. At six chains further, fossiliferous greenish, lilac, light brown, and grey quartziferous beds appear to dip S. 40° E. at 45°. These may be a faulted repetition of the beds on East Looe beach, from which they are separated by grey shales and gritty beds. On East Looe beach, grey, greenish, bluish, and lilac shaly and slaty beds, presenting in places the appearance of a laminated quartzite from the irregular distribution of veins and filaments of quartz, are overlain by very dark bluish grey shales, thick shales, and brown shaly grits. A

film of crinoidal limestone was noticed in the dark coloured shales; in the beach reefs they exhibit contrary dips, as if from flexure; the underlying beds gave a dip S. 35° E. at 45°; they contain numerous imperfect traces of spirifers and crinoids.

Disregarding the grits of Picklecombe Fort and Maker, which are discordant to everything around them, we have a downward succession from the grey and pale green quartziferous slates and shales of Rame Head and Penlee Point, to the grey and bluish slates associated with igneous and ashy materials, and in places partly calcareous, which overlie the Plymouth limestone of Mount Edgcumbe Park. Following the coast line from Rame Head to Port Wrinkle, we find pale greenish-grey and lilac quartziferous slates and shales extending as far as the Fort, south of Lower Tregantle, and forming the whole district between Millbrook, Cawsand, and Rame Head. We find these beds overlying, near the Fort, a series of buff sandstones of at least 100 feet in thickness, which overlie a thickness of at least 300 feet of calcareous shales with a mass of slaty limestone, under which another series of sandstones associated with slaty beds affords a thickness of more than 200 feet. But as this calcareous series is on the strike of the Plymouth limestones, and as the latter exhibit between Torquay and Plymouth the irregularities in thickness and mode of occurrence that might be expected from coral reefs, the passage of the one into the other is a legitimate inference. From the base of the sandstones underlying the

calcareous beds to Millendreath, the grey, lilac, greenish, and indian-red quartziferous slates, shales, and fine intercalated grits may be taken as one series underlying the Plymouth limestones, and exposed with the more marked tints in the railway cuttings between Plymouth and St. Germans.

Under these beds we have the hard greenish, reddish, and grey quartziferous slaty and shaly beds and grits of Looe, with their ill-preserved fossils. The uppermost beds of the above succession forcibly reminded me of the upper part of the Great Middle Devonian slate series of North Devon: the beds between Cawsand, Penlee Point, and Rame being identical with those of Morthoe, whilst the association with fine grits and the pale lilac tints, between Rame and Higher Tregantle, are characteristic of the same series in the Brendon Hill district, and on the southern slopes of the Quantocks, in Somerset. The resemblance is further strengthened



by the rugged coast-line and jagged-strike promontories and reefs in the vicinity of Penlee Point and Rame Head, which strongly remind one of the coast line near Morthoe.

Dr. Holl (*Quart. Journ. Geo. Soc.* for 1868, vol. xxiv. p. 452) says, "Assuming that the rocks included "between the base of the Ashburton and the top "of the Torbay limestones represent the calcareous "portion of the Ilfracombe group of North Devon, "then the red rocks of Blagdon Cross and the "Kingsbridge promontory would in all probability "correspond in position with the upper and Morthoe "portions of the same series, &c."

But the Kingsbridge beds being in line of strike with those of Bovisand Bay, which Dr. Holl compares to the rocks of Cawsand, the latter may be regarded as upper beds of the Great Middle Devonian series. The correlation of the Plymouth limestones and their associated shales and slates (*i.e.* above and below) as representative of the Lower or Ilfracombe portion of the Great Middle Devonian series is attested by Mr. Etheridge, and hardly admits of a doubt. Mr. Etheridge in the classification given in his exhaustive paper (*Quart. Journ. Geo. Soc.* 1867, vol. xxiii.), correlates the Looe grits with the lower part of the Middle Devonian beds of North Devon, the Hangman grits (in which *Stringocephalus*, *Natica*, and *Myaline* have been found). It now becomes a question as to the position of the grits of Maker and Picklecombe Fort, and of their equivalents at Staddon on the opposite shores of the Sound.

Dr. Holl says (*op. cit.* p. 437), "The red grits of "Staddon Point are much folded, and some of the "beds inverted, but the general dip is southerly, and

" above them are the grey and bluish slates with thin " grey grits of Bovisand Bay, and these are succeeded " by reddish slates partly argillaceous, and partly hard " and micaceous, like those of Kingswear, &c. The " general appearance of these rocks along the shore " of Plymouth Sound reminds one of the section on " the River Dart."

Dr. Holl correlates the slates of Jenny Cliff Bay with those overlying the Mount Edgcumbe limestone, which become interstratified with bands of grit west of Millbrook. From this it would appear as if Dr. Holl considered the Staddon grits as intercalated in the Middle Devonian series. As regards the Maker patch, we have no evidence to favour intercalation, and if it be admitted fault boundaries would be equally necessary, and the gritty beds in part of the slates and shales toward Higher Tregantle might be adduced as evidence of the fingering out, so to speak, of the grits as a lithological horizon. Still, on the whole, I am inclined to regard the grits of Maker as a faulted unconformable patch, either brought up from beneath, and so equivalent to the Looe beds, or others of older date, or as an outlier of Upper Devonian. I must, however, apologize for even putting forward these suggestions on such meagre data as I possess.

ON THE OCCURRENCE OF FEATHER ORE (PLUMOSITE) IN FOXDALE MINE, ISLE OF MAN.

By Warington Smyth, F.R.S.

The name of Feather Ore (*Feder-erz* of the German miners, *minera Antimonii plumosa* of Waller) was applied by the older mineralogists, and for some years after the publication of Professor Jameson's *Treatise on Mineralogy*, to a minutely crystalline or even capillary aggregate of antimonite, or the sulphide of antimony. This, however, is so recognisable as a variety of the well-known grey antimony ore, that the term has for the last half century been made over to a compound sulphide of lead and antimony, called by Haidinger Plumosite, and by Rammelsberg Heteromorphite. The species, although not occurring in large quantity, is not uncommon from certain mines in Saxony, and on the south of the Hartz mountains; but, as far as I am aware, has only in one or two cases been noticed in British mines.

Between the well-known sulphide of lead, galena, on the one hand, and antimonite or stibnite on the other, there exist in nature a series of minerals in which the substances lead, antimony, and sulphur are compounded in various but definite proportions.

Geokronite is that which contains the largest proportion of lead-sulphide; then follows Boulangerite; and then come Plumosite and Jamesonite, with what appears to Rammelsberg to be an identical composition. The investigations of a host of authorities give the essential ingredients of these latter minerals as being

Lead	50·61
Antimony	29·83
Sulphur	19.56

as represented by the formula $2PbS + Sb^2S^3$.

Numerous analyses, however, both of the Plumosite and of Jamesonite, show that a part of the lead is apt to be replaced by iron—up to one or two per cent., or by smaller amounts of copper, zinc, bismuth, or silver.

Other distinct mineral species of this group are Plagionite and Zinckenite.

Most of the above mineral species have been met with in mines where the ordinary ores of lead and of antimony occur, or in silver mines yielding in part the same ores;* but it appears singular, that whilst at Wolfsberg, in the Hartz, nearly all of them have been found, only one of them—Jamesonite (if we are to consider Plumosite a variety of it), is known to have occurred in Cornwall. The district around Endellion, and that lying west of the old Tamar mines, inactive as one regrets to see them now, have formerly pro-

* Some of the best examples of Plumosite were obtained from the silver mine of Bräunsdorf, in Saxony, abandoned above thirty years ago; but most notable in its day for the production of a number of interesting minerals, especially of kermesite, valentinite, and meiargyrite.

duced large amounts of antimonite, and with it occasionally Jamesonite. Many years ago a few specimens of Feder-erz from the north-west of Cornwall found their way into mineral cabinets, and at the British Museum and elsewhere are ascribed to the localities Endellion and Port Isaac. Some of the Cornish Jamesonites were analysed by Rose, and the results are quoted by Dana in his *System of Mineralogy*. We might have looked to these antimony mines as probable localities for the other minerals mentioned. This might have been thought the more likely from the presence of that striking antimony and lead sulphide, into which, however, copper enters as an important element, Bournonite, of which Endellion, and more recently, Herodsfoot Mine have furnished such magnificent crystallised examples to all the cabinets in the world.

It is then an interesting circumstance that in the Old Foxdale Mine, in the Isle of Man, well known for its productiveness in argentiferous lead ores, and in which I believe that no antimony ore has ever been seen, one of the above group, Plumosite, has lately made its appearance.

The masterly lode of Foxdale has been worked for some four miles, not quite continuously, on its east and west course, and to an extreme depth nearly approaching 200 fathoms. It varies in character, and often within short distances, to as great an extent as perhaps any lode that could be cited; sometimes, as at Beckwiths, a body of more or less orey material of five or six fathoms in width, in

other parts exhibiting powerful ribs of solid galena with several tons of ore to the running fathom, again parting into parallel branches of an ordinary lead ore on the south wall, and others of a highly argentiferous variety affecting the north side, and often with from two to six fathoms of lode material between them. Between the courses and shoots of ore is encountered (and sometimes unfortunately for very long distances) a quantity of unproductive ground in which detrital killas, or granite, and ribs of chalybite (carbonate of iron), and singular veins and seams of an indurated black clay, form the chief constituents. This latter material, cutting sharply against some of the other lighter coloured substances, gives rise to appearances very instructive as regards successive openings and fillings of parts of the lode, and reminds one of the so-called *glauch*, which plays a similar part in the small but rich veins of tellurium and gold at Nagyag, in Transylvania.*

Furthermore, the variation in appearance is added to by the fact that whilst the country rock has mostly been killas, the Old Foxdale Mine encountered granite at a medium depth—in some places only on one wall, and is now opening in many successive levels in a solid mass of that rock. No sudden alteration has been produced by the change of "country;" but fluor spar is abundant in some of the western drivings, and in the deeper levels the main or south part of the lode appears to be more frequently than elsewhere a matrix of grey quartz. In

* See the term "terra ferè lutea, *gluch*."—*Agricola, de Re Met.*, 1561.

these deeper levels a new and unusual feature has been the emanation of a gas, probably carbonic acid, from the crevices of the south wall of the lode, which has the effect of instantly quenching the flame of the candle, and at times has interfered with the work for days together.

The chief engine shaft is Bawdens, and to the west of this, ten to twenty fathoms, about the 100-fathom level, in a series of "pitches" extending up to the eighty-six, soon above which the killas comes in as "country," is the part of the mine in which the Plumosite has been found. Its *habitat* appears to be on the north side of the south part of the great lode. In other portions of the mine, about the "old shaft" farther east than the above, the well known antimonial ore of copper called fahlerz, or tetrahedrite, has been met with in spots and branches, notably at the 100 and 115-fathom levels; and the frequent tendency of this mineral to contain a large percentage of silver has no doubt had something to do with the unusual value for silver of the galena of some of the northern parts of the lode. These have in fact assayed at times from 100 to above 200 ounces of silver to the ton of lead, and have thus in many places admitted of being worked in thin strings, and in hard ground, where common lead ore would not have paid to work. It might have been expected that the two antimonial minerals, the fahlerz and the Plumosite, would stand in some relation to each other. It is true they both occur at nearly the same level; but where the latter has been found there is no trace of the former.

The Plumosite is associated with a fine-grained galena, and a vuggy or cellular quartz, with many transparent crystals; it occupies these vugs, seldom filling them up entirely, but usually attached by one portion, whilst the remainder floats loosely. Its appearance is much like that of a piece of dark cotton wool, sometimes like a little wreath of smoke, reminding one of a fine weather smoke-puff from a steamer on the horizon, or barring the colour, stand-out from the stone with filmy outlines, and—

"Si parva licet componere magnis,"

giving a miniature suggestion of the weird forms of the hydrogen flames or "rose-coloured prominences" on the edge of the sun's disk, as seen in a total eclipse. A closer examination will reveal multitudes of the finest spiculæ, bright grey metallic-lustred hairs confusedly flung together, and sometimes so felted into one plane, the prisms crossing in different directions, as to look like a bit of rag or woven cloth.* The colour, however, is always grey, and hence differs at once from the *Zundererz*, or Tinder ore of the German mines, in which a notable proportion of silver, about 2 56 per cent., is revealed by the reddish colour due to an admixture of the mineral Ruby silver ore. One or two of the specimens had a slight touch of that dull red colour which characterizes the *Zundererz;* but in view of the minute quantity of the mineral

* For the sight of a good series of these specimens, as also for the particulars of their limited occurrence, I am indebted to Capt. William Kitto, the resident manager of the mine.

it is difficult to decide whether the redness may be due to one of the "ruby silvers" or to kermesite.

Under the microscope the prisms come out distinctly; but it is difficult to be satisfied about their terminal faces. Other very curious features are now discernible; the hair-like prisms often affect curvilinear forms; arcs of circles and parabolas are not infrequent, and in some cases a coil of the microscopic hairs forms a perfect ring of very uniform thickness. The long crystals are flexible and elastic, and those which are anchored at one end will be seen to wave to and fro in a current of air. Some of these are adorned with minute bright crystals set at intervals upon them like beads upon a string. These latter appear to be cubical, and may probably be pyrites.

Before the blow-pipe a group of these crystals runs together rapidly, and abundant fumes arise, coating the charcoal white and yellow with the oxides of antimony and lead. With soda a brownish bead is obtained full of very minute globules of lead, scarcely visible except with a lens.

I cannot but regard it as a singular circumstance, under the data which we at present possess, that this new occurrence of Plumosite should be connected exclusively with galena, quartz, and their usual associates. Rammelsberg insists that the name Heteromorphite, which he proposed for it, should be regarded as indicating only the minutely crystalline or capillary varieties of Jamesonite; but its appearance at Foxdale independently of other antimony minerals,

and immediately superposed on the galena, invites attention. Von Kobell observed the chemical identity of the two as far back as 1830. The Plumosite is, in point of date of deposition, the last mineral which has been formed in the little caverns of the lode, and its delicate fibres and webs seem to indicate, whatever process we may call in to explain their origin, a period of quiet and undisturbed action.

ON FOSSILS FROM THE ROCKS OF CORNWALL.

SOME OF THEM NEW TO THE LIST.

By C. W. Peach, A.L.S., F.R.P.S. Edin.

Thinking about your annual meeting, I have made a little rummage amongst my heaps, gathered in many districts, and from these I have selected the few fossils sent, which I hope are worth your acceptance; with one exception, which I have noted in the paper, they may be added to your splendid collection. I have one regret, not being able to be with you. This age and distance prevent.

FAVOSITES FIBROSA, *Goldf.*

Figured in *Siluria*, p. 119, fossils 18, figs. 7, 8, and in plate 41, figs. 1, 1*a*, from the Wenlock limestone. In table ii. p. 618 of Etheridge, "On the Physical Structure of West Somerset and North Devon," in the *Quarterly Journal of the Geological Society of London*, 1867, it is noted as found in the Lower Devonian at Meadsfoot and Torquay, in Devonshire, and at Looe, Cornwall. Of the Silurian specimens, Sir Roderick says, "This variety is always found encasing spiral shells." I am not aware on what the above-mentioned Devonians were "encased." The

one from Lantivet Bay, now exhibited, is on a crinoid stem, as may be seen at the pointer, partly "encasing" it, and on the little drawing made by my son. The coral is stouter than the Silurian one. I have retained the specific name until more is known about the Devonshire specimens.

PROTOVIRGULARIA DICHOTOMA, *Mc Coy.*

In Mc Coy's *Palæozoic Fossils*, pl. 1B, figs. 11, 12, page 10. One specimen only is mentioned from Lockerby, Scotland. Since this was found it has been turned up in two other Scotch localities, also in Silurian rocks, in both places rare. The specimen now sent is from the Old Slate Quarry, at the Van, Blackhead, near Porthpean, Cornwall; in the present unsettled state of the geology of the county, whether in Devonian or Silurian rocks it is hard to say. I got it before the meeting of the British Association at Plymouth, in 1841. I could not think it was an Encrinite. I however waited for the meeting of the same society, in 1850, at Edinburgh, and called the attention of the late Professor Edward Forbes to it; after careful examination he pronounced it a *graptolite*, others present did the same. Even after this decision I was rather sceptical, from finding in the geological works I then had access to that *graptolites* had ceased to exist with the Silurian period. A short time ago, from having seen Mc Coy's work above mentioned, I at once saw that the said-to-be *graptolite* was like the *Protovirgularia* of Mc Coy. In this

opinion several well-versed in fossil lore fully agree with me. It is a most interesting form, and a nice addition to the Cornish list of fossils. It has been compared by some to the *Virgularia mirabilis* of our seas, and from this zoophyte part of the generic name is taken. Mc Coy has figured branched specimens of it. I have a drawing of the *central stem* of one from the Van, which I exhibited at the meeting of the British Association in 1841, also branched in a similar manner. It would be a good thing if some one would closely examine this quarry and the rocks around. Many other very interesting fossils have been found there, as well as this beautiful one, and more of it may be found—I saw some other small pieces of it—and then its true history might be fully made out.

LINGULA SQUAMIFORMIS (?) *Phillips.*

In my early days of fossil hunting (getting on now for almost half a century) I got one "distorted specimen," like those now sent, at Ready Money Cove, near Fowey. It was very black, and shining like the elytra of a beetle, and at first I thought it was so. I however hesitated about it, and put it aside into my doubtful corner. At last I sent it to Mr. Davidson, our great *Brachiopoda* authority, for his opinion. He, with his usual urbanity, examined them (the two on the same stone, marked No. 3), and said that he considered them, as far as he could judge, to be "distorted *Lingulæ*." In this I fully

agree, from my now extensive acquaintance with those from the Palæozoic, &c., rocks I am surrounded with. The rounding up has been caused by the curious movements in the strata, especially of Cornwall, well-known by the distortions in many fossils to collectors. I have thought it right to add the note of caution to the specific name as a saving clause, it being added by myself. This is another nice addition to the Cornish list.

ORTHIS CALLIGRAMMA, *Dalm.*

Siluria, pl. V. figs. 7-9; pl. X. fig. 21, "Lower Silurian." This specimen is the first I found in the quartz rock of the Great Cairn, Gorran Haven. I am again indebted to Mr. Davidson for the name. It was in a large and heavy block, as much as a very strong man could get into a boat, and afterwards carry to my house. It was a very tough job afterwards to break it into pieces for examination. It proved to be the only specimen in it. In all my subsequent examinations I found on the whole—in these quartz rocks—they were rather rare. When I got this specimen I sealed the letter I sent to Sir H. De la Beche, then at St. Austell, when he was surveying Cornwall. I had previously sent him from the killas some very obscure things; these he thought not organic. The wax impression I made on the letter he fully accepted as representing a true and good fossil. I should like to have this again for a memento. I will send a wax model for your museum, or you may take the one on the specimen. I can make another.

SCAPHASPIS CORNUBICUS, *Lankester.*

Two small portions of "*Cephalaspidian* fishes" were not sent to your museum when the large collection of mine was, no doubt because I was in Scotland at the time. They have lately turned up in my hoards; these I now send with part of the old reference tickets on, to be placed with the other fish remains from Lantivet Bay, &c. They were figured by me in your *Transactions* for 1848, pl. II., figs. 1-3, 7, 8—7, as "striated pieces of fish;" as "scales." In the *Monograph of the Fishes of the Old Red Sandstone of Britain*, by Messrs. Powrie and E. Ray Lankester, published by the Palæontographical Society in 1870 (pl. X. figs. 4, 4*a*), you will find a similar specimen figured as probably "ventral scales." Figs. 1-6, pl. VII., are portions of various species of *Scaphaspis* and *Pteraspis*, and are figured to show "the surface ridges on the shields." If you refer to my paper before mentioned (pl. II., figs. 7, 8), you will find similar ridges depicted, and such surface ridges may be well seen on the specimen (No. 6) herewith sent, and also on some in your collection. In a short paper by Professor E. Ray Lankester, in the *Proceedings* of the Geological Society of London, 17th July, 1868, "On the Discovery of the Remains of *Cephalaspidian* Fishes in Devonshire and Cornwall, and on the Identity of *Steganodictyum* of Mc Coy, with genera of these Fishes," Mr. Lankester says, "that the late Mr. Salter, in looking over the collection of

the supposed sponge (*Steganodictyum Cornubicum*) of Mc Coy, from the Lower Devonian slates of Mudstone, with his usual sagacity . . . came to the remarkable conclusion that McCoy's supposed sponge was actually the cephalic plate of a *Pteraspidian* fish;" and at page 547, further says on the subject, "that the fish-head plates from the Lower Devonian rocks of the Eifel, and of Devonshire and Cornwall, must now be known as *Scaphaspis Cornubicus*." In this opinion he is fully borne out by Professor Huxley, Mr. Henry Woodward, and the Rev. Mr. Symonds; and at the conclusion adds, "I will not venture to remark upon the important bearing which the discovery of these fish remains must have on the recently disputed age of the strata in which they occur." This may be added as a new fact in Cornish geology.

In the *Monograph* of the Palæontographical Society, p. 61, Professor Lankester further says, "that Mr. Pengelly, Mr. Peach, and the Royal Geological Society of Cornwall, have kindly lent me their specimens for further examination." Oh, how I wish he would describe them! He is so well able to do so; I weary for him to do it. Whenever they are described, I am convinced that many new genera and species will be added to the Cornish, &c., list of fishes, and that they will prove to be some of the finest of the kind ever seen. I much regret that they are so broken. They are abundant in Lantivet Bay and at Polperro.

THE QUARTZOSE ROCKS AND FOSSILS OF THE NARE HEAD, ETC., DISTRICT.

I cannot resist saying how pleased I am that Mr. Collins has found fossils in the Silurian quartzose rocks in the Manaccan district, and that they prove to be like those of the Great Cairn at Gorran Haven, and the rocks of Caerhayes and Gerrans Bay; thus confirming my opinion recorded in your *Transactions*, that the hard beds at the Nare Head were fossiliferous, they being so much like those of Gorran Haven, &c. Another discovery adds to my pleasure, Mr. Collins's finding "tubular cavities" in these rocks. I believe they will prove to be like those I got at Gorran Haven, &c., and at Durness and Assynt in Sutherlandshire, in similar quartzose Silurian rocks. Sir R. Murchison figures them in *Siluria* at page 40, fig. 14; also similar "tubular cavities" from the Stiper stones, and has named them *Scolithus linearis* of Hall.

In the *Quarterly Journal of the Geological Society of London*, vol. xv. figs. 29 and 30, and at page 418, they are named *Arenicolites*, or Annelide burrows. I sent a specimen of these "tubular cavities," got by me in Cornwall, to your Museum long ago. In Sutherlandshire they cover acres of quartz rocks (in Assynt especially), and are not rare at the head of Loch Eriboll. They remind me much of the recent tubes of *Sabellaria alveolata*, which form such beautiful masses of sandy tubes on our coast. The finest I

ever saw were on a large outlying rock near Caerhayes, Cornwall.

I must apologise for the length of this paper. My heart is in the matter; I am so anxious for the furtherance of Cornish geology, and I hope you will excuse my gossip.

LIST OF SPECIMENS SENT WITH THIS PAPER.

1. *Favosites fibrosa*, west end of Lantivet Bay.
2. *Protovirgularia dichotoma*, Van, Blackhead.
3. *Lingulæ*, Ready Money Cove, Fowey.
4. *Orthis calligramma*, Gorran Haven.

5 and 6. Portions of *Scaphaspis*, from Lantivet Bay.

NOTE ON THE OCCURRENCE OF STANNIFEROUS DEER HORNS IN THE TIN-GRAVELS OF CORNWALL.

By J. H. Collins, F.G.S.

In the British Museum, and in the Museum of this Society, are several fragments of deer horn containing oxide of tin. Dr. Potts had similar specimens in his collection, and there are others in several private collections which have come under my notice. A great many of these are said to have been found formerly in the tin stream-works of the Carnon and Pentewan Valleys, and to have been sold as black tin to the smelters. The specimens in the British Museum appear to contain a large proportion of tin oxide, but I have not been able as yet to learn what is their specific gravity, much less to obtain fragments for analysis. In some parts the original horn structure seems to be almost entirely preserved or reproduced in oxide of tin, and there are even minute crystals of this substance visible in places.

The specimen belonging to this Society has been very kindly placed in my hands for examination, both chemical and microscopical, by the Council. I now return it, with my thanks, and with my observations thereon. It appears to have belonged to the red

deer (*Cervus elaphus*), but the fragment is so incomplete that there is still some doubt on this point.

The specific gravity of the whole mass, and also of a small piece cut from its less compact end, is 2·7. It contains only about 12 per cent. of organic matter. The specific gravity of unaltered (recent) deer horn (fallow deer) is, I find, 1·26 (so that this is more than twice as heavy), and it contains 62 per cent. of organic matter. This has been therefore highly altered in some way. The following analysis shows what is the nature of this alteration.

Calcium Phosphate	80·04
„ Carbonate	2·24
„ Fluoride	·50
Ferrous Sulphide	1·66
Ferric Oxide	·62
Stannic Oxide	2·60
Silica	·22
Organic matter and loss	12·12
	100·00

It will be seen in this specimen that the organic matter has been reduced to a very small proportion, and that there is both iron pyrites and oxide of tin present. The amount of tin oxide is certainly small, far too little to make this particular horn suitable for the purposes of the smelter, but, as will be seen, it is still an important constituent of the mass.

The microscopic appearance of the horn, as seen in thin sections, shows that the oxides of tin and iron, and the iron pyrites, have found their way to the interior of each cell, and are visible throughout the structure, although somewhat more abundant

near the periphery than in the interior. This mode of occurrence shows that these substances reached the cells in a state of solution, and percolated through the walls. As far as the iron pyrites are concerned there is nothing particularly remarkable in this; but the case is otherwise with respect to the tin oxide. Oxide of tin in its native condition is one of the most insoluble of substances, and we can only suppose that the tin was brought to the horn in the state of a soluble salt, such as the fluoride or the chloride. In a paper presented to the Mineralogical Society I have brought forward reasons in support of my conclusion that in most, if not all, cases where tin is now found fluorine has played the part of a carrier. I will merely remark here upon the interesting proof which this specimen affords of the existence and circulation of stanniferous solutions in such geologically very recent times as those to which the formation of the tin-gravels must be referred.

NOTE ON THE SUPPOSED SERPENTINE OF THE PARISH OF ST. VEEP.

By J. H. Collins, F.G.S.

The supposed serpentine of the parish of St. Veep was first discovered by Mr. C. W. Peach in the year 1846, and described by him in the *Transactions* of this Society.* At the same time he presented a number of specimens of the rock to the museum. Mr. Peach states that the serpentine is associated with gabbro, as in the cases of the Lizard serpentine, and of the little patch occurring in Gerrans Bay. I have not seen any of the gabbro to which he alludes, but I have lately obtained a specimen of his supposed serpentine. It is soft, and takes a very good polish, and I must admit that it looks very much like serpentine. The rock occurs in association with beds of altered slate, which Mr. Peach says are fossiliferous on the north side. The strike of the beds is N.W., and the dip is N.E. I believe them to be of Upper Silurian age, but they are marked as Devonian on the Government Map.

There is one feature in connection with this rock which at once suggests a doubt as to its really being serpentine, and that is the occurrence of quartz as

* Vol. vi. p. 31.

its associate. To say the least, this is a very unusual companion; indeed, I do not remember ever having met with quartz in contact with true serpentine. To settle the point, I have recently made an analysis of the substance (after carefully separating the quartz). The results of this analysis are given in column *a*; in *b* I have given the composition of a dark green serpentine from the Lizard district (by Mr. J. A. Phillips); in *c*, of a yellow serpentine from the Shetland Isles (by Dr. Heddle); and in *d*, of a pale green serpentine from Japan (by Professor Church).

	a.	*b.*	*c.*	*d.*
Silica . . .	33·30	38·86	44·003	45·56
Alumina . .	14·61	2·95	.....	.....
Ferric Oxide .	6·93	1·86	·108	.....
Ferrous Oxide .	28·81	5·04	6·286	.....
Magnesia . .	1·89	34·61	36·714	41·75
Potash . }	2·0	0·33	.....	.....
Soda . }		0·77	trace	.....
Water . .	11·76	15·52	13·2	13·04
	99·30	100·30	100·311	100·35

It will be seen that the serpentines *b*, *c*, and *d* differ from each other a good deal in composition, but they agree in containing a very large proportion of magnesia, and little or no alumina. The presence of nearly 15 per cent. of alumina in the St. Veep rock, and of less than 2 per cent. of magnesia, shows that it can in no sense be regarded as a serpentine. It is, indeed, a very ferruginous clay stone; a layer, in fact, of hardened ferruginous mud of no special geological importance, and only interesting on account of its susceptibility to polish.

NOTES ON THE GEOLOGY OF THE SOUTH-EAST BORDER OF CORNWALL.

By R. N. Worth, F.G.S.

These notes briefly refer to two matters of interest connected with the geology of Cornwall—one chiefly stratigraphical, and the other palæontological.

THE GNEISSIC ROCKS OF THE EDDYSTONE AND SHOVEL REEFS.

The Eddystone Reef is claimed by Mr. Wallis, the author of the *Cornwall Register*, as part of this county; and the Shovel Rocks, in Plymouth Sound, on which the central portion of the Breakwater is founded, have quite as much claim to be considered Cornish as Devonian. Fifty years since the late Mr. John Prideaux described the rocks of the Eddystone as granitic, gneissic, and intermediate, considering the gneiss of the "house rock" to be the only example of that rock in England.* Recent operations at the Eddystone, in connection with the erection of the new lighthouse, have shown that Mr. Prideaux's assignment is perfectly correct. Specimens which I have procured exhibit examples distinctly granitic, and distinctly gneissic, with intermediate characteristics in almost every stage of gradation. As I have said elsewhere, "Probably none of the Eddystone rocks can be regarded as in the ordinary sense typical

* See *Plym. Inst. Trans.* (1830), "Geology of the country near Plymouth."

gneiss or typical granite, but they partake of the characteristics of both in a very curious and ofttimes puzzling way."

Although Mr. Prideaux was mistaken in supposing that the gneiss of the Eddystone was the only gneiss in England, it has usually been regarded as the only occurrence of that rock in the West of England. I have recently ascertained, however, through the fortunate preservation of portions of the rock removed from the Shovel Reef when the Breakwater Fort was built, that the rocks there are gneissic also. We have thus conclusive proof that the Eddystone Reef is no mere isolated phenomenon, but part of an extended granitoid formation occupying the area between the Eddystone and the Breakwater—eleven miles from N.N.E. to S.S.W., and in all probability skirting the coasts of Cornwall and Devon and stretching into the Channel for a much greater distance.

Much evidence has recently been obtained of the existence of an extensive submarine granitic area off the southern coasts of the two counties,* which we may in all probability associate with the metamorphosis of the rocks of the Gorran district, in Cornwall, and of the Bolt district, in Devon. The point is an exceedingly interesting and important one in connection with our stratigraphical geology; and the discovery of the true character of the Shovel Reef is not only a material contribution towards its solution, but may also help to explain the "contortions and

* *Vide Trans. Dev. Association*, 1879–80. Papers by W. Pengelly, F.R.S., and A. R. Hunt, F.G.S.

displacements" of the rocks on both the Cornish and Devonian shores of Plymouth Sound.

THE QUATERNARY FAUNA OF CORNWALL.

With the exception of the cavities caused by the waves in the rocks of its coast, and the "vugs" which occur in its mines, Cornwall, so far as I am aware, does not contain any caverns. There are comparatively few patches of limestone in the county, and none of any large extent; and it is in limestone commonly—the result of the action of water—that caves are found. Wanting the caves, Cornwall is deficient of the cavern fauna which forms such a remarkable feature of the Quaternary period in the sister county. It may be fairly questioned, however, whether Cornwall is not entitled to claim at least part of the mammalian remains found so near its own borders as the caverns of the Plymouth limestone, the western extremity of which indeed extends to the Cornish side of the Hamoaze at Cremill. There is evidence that a portion at least of the ossiferous deposits to which I refer found their way to the fissures, in which they were discovered, by the agency of water; and there is further evidence of currents following the direction of the present Tamar as well as of the present Plym. The fact that it is impossible to draw a hard and fast line with regard to these deposits between the two counties induces me to lay before the Royal Cornwall Geological Society a full statement of the cavern fauna of the Plymouth limestone, embodying the results of my own investigations and discoveries during the past two years.

Cavern research at Plymouth commenced so far back as 1816, when an ossiferous fissure was discovered at Oreston, which was the first in this country made the subject of scientific enquiry. Since then there have been numerous "finds," some of considerable extent, and my belief is that hardly a year has passed since that date in which the quarrying operations so continuously carried on around Plymouth have not yielded traces of this ancient fauna.

The localities which have been productive are Oreston (chiefly in the years 1816, 1820, 1822-23, 1843, 1858-59, 1878-79); the Hoe (chiefly 1838 or 1839); Cattedown; Stonehouse (1865, 1879-80); Mount Wise (1861). Oreston has been by far the most productive, and next rank Stonehouse and the Hoe.

The animals whose remains have been clearly identified are the mammoth (*E. primigenius*), the woolly and the partitioned-nosed rhinoceros (*R. tichorhinus* and *leptorhinus*), the cave lion, the cave and the grizzly bears, the cave hyæna, wolf, fox, wild cat, weasel, the horse—fossil and plicated toothed, the ass, the urus (*Bos primigenius*), the long-fronted ox, the aurochs (*Bison priscus*), the lesser bison, large deer or elk, small deer (roe deer?), red deer, reindeer, hog, sheep or goat, hare, an unidentified rodent, and some voles. The hippopotamus is a doubtful member of the fauna, but bones of man have been found. The reindeer was unknown to Plymouth until the present year. The whole of this list I think we may regard as belonging to the Cornish Quaternary fauna.

Royal Geological Society of Cornwall.

THE SIXTY-EIGHTH

ANNUAL REPORT

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John Rowe, The Terrace, St. Just.
Stephen Thomas, Redruth.

Names of Associates whose exact Addresses are unknown.

Hall, R. T. | Phillips, John

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—It would be impossible for me, living as I do, so to speak, out of the world of science, and therefore not posted up in its daily discoveries and advances, to follow the example of my worthy predecessor, and to give you an address of scientific value. I console myself, however, by thinking that this honourable and ancient Society is composed not only of some of the most learned and most noted votaries of science, but also, to a large extent, of those who, like myself, have other vocations in life, and can therefore only occasionally enjoy the wonders of geology as they cross their paths. As one of the latter, I must claim your indulgence, ladies and gentlemen, for any shortcomings in this address, as also the forbearance of our more learned and scientific co-members for any rusty and unscientific descriptions of which I may be guilty.

Last year I placed before you, in a very brief and rough way, a few hurried remarks on what appeared to me, from my own observation, to have been the probable process of formation of veins of coal, especially in the South Wales coal basin. The subject is indeed a most interesting and almost inexhaustible one, and I might have been tempted to trouble you with some further remarks on it this year; but in the meantime it has been so scientifically and ably treated in a paper read before the Geological Section of the British Association at their recent meeting at York, that I felt that any who cared to follow up the investigation would obtain far more information from this source than from any further information which I could furnish them with. I therefore changed

my subject, and will ask you to follow me in a short notice of a little trip I had to make this summer to the most interesting volcanic district of *Mont Dore* in Auvergne, in the centre of France.

It was not indeed by any means a trip of unmixed pleasure to myself. I had been ordered there by my doctor to go through a course of mineral waters, and the only redeeming point in undergoing this most disagreeable process was the lovely scenery and interesting surroundings. Nature had been most bountiful in her good gifts, but man was niggardly and grasping in supplying even the necessary wants of life.

My friend, Sir John Lubbock, had led me to expect much of geological interest, but I must say the actual far exceeded my most sanguine expectations.

Armed with that most delightful of books, Scrope's *Geology and Extinct Volcanos of Central France,* which Sir John had recommended to me, I soon felt that many a week of interest might be passed away in rambles and excursions in this district; but, alas! my ramblings were to be of a very limited nature, for as soon as I had resigned myself into the doctor's hands at the "Etablissement des Bains," at Mont Dore, my personal liberty ceased; for even when not undergoing the process of parboiling, which occupied several hours of each day, my walks were not allowed to be of a lengthy or in any way exhaustive character.

However, the whole country is intensely interesting, and the baths themselves being situated in one of the most curious portions, I was able, even within the prescribed medical limit, to visit and see much which filled the mind with wonder and amazement at Nature's great part.

Arrived at Clermont Ferrand (the chief town of the department of the Puy de Dôme, and the starting-point, as it were, for the Mont Dore country), objects of the greatest interest at once commenced. Amongst them, in the suburbs, is a spring, so charged with carbonate of lime that it solidifies with this salt any object suspended in its waters. This property of "petrifying," as it is commonly called, is naturally a source of great income to its pro-

prietors, who charge the public handsomely for availing themselves of its properties.

The grand old cathedral of this town is built of ancient lava, or trachyte, which material, although dark and gloomy in aspect, conveys a somewhat solemn and mysterious character to the old edifice, and makes one think of the past, when the huge masses of which it is constructed formed part of the molten streams, or seas, flowing and heaving in this very neighbourhood.

Away in the plains, at no great distance from the town, are the undisturbed beds of sedimentary rocks, belonging, I believe, to the Tertiary series, and rich in fossil remains. I did not visit them myself, so can only speak from hearsay; but from them I obtained the fossils you see on the table; viz., the jaw of a rhinoceros, and the wing-bones of some natator or duck; but perhaps the most interesting of all these fossils (although I value them all much) are the three specimens of *fossil eggs*. One is the egg of a land tortoise, which is by no means uncommon; but the other two (one of which is cracked) are those of a fresh-water diver, such as a grebe. These eggs would appear to me to prove to a certain extent that this particular deposit of mud took place in the spring time.

I am happy to say that, on showing these fossils to Professor Etheridge, I received a most satisfactory confirmation that they were what they professed to be, and, moreover, that they were of great interest. The only exception he made was to this nodule of silica, which was said to be the ball of the hip joint of a rhinoceros; but I believe this was a case of *bonâ fide* ignorance on the part of the collector.

I gather from Scrope that this Tertiary formation consists here of strata of clay, marl, limestone, and sandstone, deposited from freshwater lakes existing in the depression of the elevated granitic tract; that sometimes the limestone-beds are more or less mixed with fragments of basaltic lava, scoriæ, and volcanic ashes, &c. To use his own words, "the heavier and larger fragments occupying the lower part of each stratum, the lighter and smaller stopping in the upper parts, suggesting the obvious idea that these fragments, after ejection from a volcanic vent, had fallen through the air into

the lake at the time the stratum in which they occur was in the condition of very soft calcareous mud." (p. 15.)

But, as I said before, I saw nothing myself of the sedimentary deposits of the neighbourhood, and only allude to them now in explanation of the few fossils which lie before me. We will therefore return to a very brief consideration of the volcanic district around Clermont Ferrand and the baths of Mont Dore.

Let us ascend in fancy one of the many "puys" or "pics" to the west of the town, and take a survey of the surrounding country. What a curious and wonderful sight awaits us. It may well be that we find ourselves standing on the very lip of an extinct crater, the lava stream merely covered over with a skin of vegetation. At any rate, all around us will be seen abundant and all-convincing proof of the volcanic origin of the district. One "puy" after another rises conelike in succession from the plain below, some of them actually *extinct craters*, with their streams of lava and scoriæ clearly traceable from their very lips, pouring into the plain below; others apparently have formed part of a trachytic or basaltic stream, but have afterwards been separated by a convulsion of nature. On the sides of some lie masses of ashes and a lava stream, as fresh almost as if just ejected from Vesuvius or rabbled out from one of our copper furnaces.

Here are some specimens in confirmation of this wonderful freshness and similarity to the daily produce of an ordinary smelting works. This is a specimen of lava from this district, and here is a piece of slag which I picked up the other day in our works. Can anyone deny a similar origin to both? Here again is a piece of scoriæ, or ash, or (as it was sold to me for) calcined granite, and here is a bit of our works' "cobbing," that is, fire-brick which has been brought into contact with the heat and work of the furnace. Surely one may say that the two stones are as like as two peas, and must have gone through similar treatment to make them so.

I believe there are nearly eighty of these puys or pics, the highest in the vicinity of Clermont Ferrand being the *Puy de Dôme*, which is nearly 5,000 feet above the sea, and gives its name to the

department. The sides of some of them are now clothed with vineyards, recalling the fertile slopes of Vesuvius, on which the vine—the grape of which produces the celebrated "Lachryma Christi" wine—is grown.

The road from Clermont Ferrand to the Baths of Mont Dore (a distance of some twenty-five miles) is through this most interesting volcanic district. The scenery is charming, especially when nearing the little town, where the road defiles through a thickly-wooded valley or gorge, with beautiful peeps of the distant range and of the peaks at the head of the valley of the Dordogne.

Once arrived at Mont Dore, and in the hands of the doctors, I found my time considerably taken up by the various processes of the cure, and I had only leisure or permission to make but short expeditions. There are however many most interesting spots within easy distance of the baths, and quite close around the village may be seen occurrences of great value to the geologist.

Here is a section which I took from a cutting on a new road within a mile of the "etablissement." This is the surface of the road, above the green turf of the natural surface. These on each side are large blocks of trachyte; on the top are a few lumps of what appeared to be partially decomposed granite. It occurs to one that these latter must have been ejected from the same vent as the trachyte, *torn away*, as it were, from the granite mass, which we are told underlies in this country the newer volcanic rocks, and through which they were ejected. This yellow stuff is a *soft* sort of clayey marl, evidently a deposition from water, and it puzzled me much to account for it, enveloping, as it does, these volcanic missiles, until I consulted Professor Etheridge, who suggested that it might be *volcanic mud*, emitted likewise from the crater. That these ebullitions of torrents of water do occur during eruptions is a well-known fact, and I feel more satisfied with this explanation, rather than by supposing that the volcanic masses had fallen into a lake which then filled the valley, and was depositing layers of sedimentary rocks, the centre portion of which have now been washed away by the action of the river Dordogne.

One of the most interesting expeditions I was able to make was the ascent of the *Pic de Sancy*, the highest mountain of central France, being over 6,000 feet above the sea, and 3,000 feet above the Baths of Mont Dore. This mountain is composed chiefly of what is termed porphyritic trachyte, with layers of scoriæ, and a sort of tuff or pumicestone, and beds of varieties of trachyte and basalt. *These latter all lie parallel to the slope of the mountain*, thus pointing in an unmistakable way to its volcanic origin. Here are a few specimens I picked up on the mountain, which will give some idea of the different kinds of rock we are dealing with. The actual *vent* or crater is not now to be traced. It seems to have been destroyed by the ordinary processes of nature; viz., the effects of frost, snow, and rain, at this great altitude.

The view from the summit is very striking and beautiful. We have stretched out below us, and around us, and again in the far distance, this exceptionally-marked volcanic region. Away to the north are the many "puys" or peaks, of which the Puy de Dôme is the chief, and of which I have spoken before. To the south again is the Cantal range, with the Plomb du Cantal towering above its neighbours. East and west the distance looks flatter and more plain-like, as if Nature had dealt less roughly in the formation of the earth's surface in those parts. It is indeed an extraordinary theme to dwell upon, when one looks down on these beautiful smiling valleys and glens, which run down from the volcanic ridges (or "divides," as they would call them in America), now teeming with an industrious population, and luxuriant in cultivation and timber,—to think that they were once occupied by seething masses and heaving streams of scoriæ and lava; but that such was the case no doubt can now exist. Look right below us, into the so-called "Gorge d'Enfer." Here enormous blocks of trachyte, porphyry, basalt, and other like igneous products lie tumbled about in indiscriminate confusion, just as they seem to have been originally ejected from the crater. Almost vertical dykes of porphyritic trachyte start up from the Gorge, forming needle points (or "aiguilles") nearly as high as Le Pic de Sancy

itself, relics of the undisturbed current as it originally ran over the lip of the crater.

What has caused the formation of the existing valleys is a question of great interest. I cannot myself believe that the causes we see at present at work—I mean such as the unimportant little streams of the Dore and the Dogne, and such as we now know them—*can* have formed them, even supposing that they have been running for countless ages.

It may be, as supposed by some of our most able men, that there were *floods* at the time of these volcanic outbursts, such as we have no conception of in the present day, arising from such causes as the melting of snow at being brought in contact with the lava, or from the prodigious storms of rain which often accompany an eruption nowadays, or from the pouring out of the contents of some internal crater lakes. The fact that boulders of volcanic rocks have been found at high elevations, and at the distance of twenty miles from the spot whence they must have been emitted, seems to favour this flood theory.

I must say, however, myself that I must confess to a great difficulty in believing that water is *alone* the cause of these *seams* in and *cuttings through* some of the hardest of rocks, such as trachyte and basalt. These were doubtless lava currents or seas, covering the country in different directions, in varied width and depth, differing in composition, and consequently in fluidity. I cannot help thinking that there must have been a great cracking, so to speak, when they cooled, which perhaps might have been very rapid, or perhaps there might have been some later disturbances, and so large chasms were formed. These cracks so formed then became the channels through which the drainage of the high lands flowed.

But whatever was the cause, Dame Nature's work in that district is beautiful and interesting in the extreme, and I cannot wish you better, ladies and gentlemen, than hope that, should it be your fate to be sent from your happy homes in search of health (which I trust it never may be), you may be banished to as lovely and interesting a country as that about which I have now endeavoured to tell you a very little.

I must now conclude, thanking you most sincerely for your kind patience, by a few words about our Society itself.

We have to regret the loss from our roll by death of some of our oldest members—the Rev. Thomas England, F.G.S., &c., honorary member, of North Lew, Devon; James Tennant, F.G.S., of London, honorary member; the late Earl of St. Germans, a life member, and warm supporter of our Society; Mrs. Richard Harvey, of Dartmouth; and lastly, I must allude with profound respect and deep sorrow to the great loss we have sustained in the death of our old friend and neighbour, Mr. Day Perry Le Grice, M.A., of Trereife. Not only is his loss almost irreparable to many of his large number of personal friends, but to the Society itself the want of his counsel and sympathy is a matter of the gravest importance.

Once more I thank you for your kind forbearance in hearing me so patiently; and before I sit down I must return you my heartfelt thanks—*first*, for the honour you did me in electing me to this chair, which I shall now resign into far better and abler hands; and *secondly*, for the very kind feeling which you have always exhibited towards me during my term of office. Believe me, it has been a matter of the greatest pleasure to me, and one that I have most fully appreciated, being brought into closer contact with the members of this ancient Society, and I shall always look back in after years with pride to the fact that I have once filled the proud position of President of the Royal Geological Society of Cornwall, of which many of my family have in past years been active members.

REPORT OF THE COUNCIL.

In accordance with a resolution passed on the 5th November last, suggesting some change for the better in the proceedings of the Annual Meeting, your Council resolved on economising time by placing their report before you in a printed form, and hope by compressing the more formal portion of the business to attain the object in view.

Several valuable additions have been made to your Museum during the past year, a considerable number of specimens being presented by Mr. H. B. Guppy, of Falmouth. They lie on the table, and will be found particularized in the report of your Curator. In a recently issued portion of the Palæontological Society's Transactions some of the fossils in this Society's Museum are figured by the well-known palæontologist Mr. Thos. Davidson, F.R.S.*

The manuscript of the Library Catalogue, mentioned at the last Annual Meeting as being in preparation, has been completed, and a portion of it is already in type. Your Assistant Curator and Librarian is therefore able to devote more time to the arrangement of specimens which have been acquired in recent years.

About nine hundred visitors have entered their names in the Visitors' Book, though a far larger number of persons have inspected the collections.

The Science Classes carried on by Messrs. Barnett and Corin in the class-rooms of the Society continue to do good work, and it is proposed to distribute the prizes obtained by the successful students in the Museum this evening.

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* See Brachiopoda Supplement, plate xlii.

During the twelve months that have elapsed since we last met in this room the Society has lost one of its oldest and most valued members, Mr. Day Perry Le Grice; and the Council refer with sincere regret to the removal by death of so staunch a friend and adviser. Mr. Le Grice was especially instrumental in locating the Society in its present home, and was ever ready to interest himself in all that concerned its welfare or advancement. He died on the 19th March last, having been just fifty years a member of the Society. On the same day died one of our life members, the Earl of St. Germans. Mrs. Richard Harvey, one of the first of our lady members, has likewise been taken from us. The Rev. Thomas England, of North Lew, Devon, one of our honorary members, has also recently passed away.

The Council desire to recommend the election of Mr. Thomas Davidson, F.R.S., as an honorary member, and of Messrs. Frederick Holman and Richard Pearce Couch, of Penzance, as ordinary members of the Society.

GEORGE BOWN MILLETT,
Honorary Secretary.

PENZANCE, *4th November*, 1881.

LIBRARIAN'S REPORT.

THE following works have been added to the Library:

I. TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies, Editors, and other Donors, or purchased.

Anglesey, Brecon, &c. Dr. C. Le Neve Foster's Report upon the Inspection of Metalliferous Mines in the Counties of Anglesey, Brecon, Cardigan, Carnarvon, Denbigh, Flint, Merioneth, Montgomery, Radnor, and Shropshire, and in the Isle of Man, for the year 1880. Folio.

[Presented by Dr. Le Neve Foster.]

Boston. American Academy of Arts and Sciences. Proceedings: New Series. Vol. vii., part 2. 8vo. Boston, 1880. Vol. viii., parts 1, 2. 8vo. Boston, 1881.

Bristol. Bristol Naturalists' Society. Proceedings: New Series. Vol. iii., parts 1, 2. 8vo. Bristol, 1880–81.

——. Nineteenth Annual Report, List of Officers, &c. 8vo. Bristol, 1881.

——. Catalogue of Books in the Library, May, 1881. 8vo. Clifton, 1881.

Cambridge (Mass.) Museum of Comparative Zoology, Harvard College. Memoirs:

——. Report on the Fossil Plants of the Auriferous Gravel Deposits of the Sierra Nevada. By Leo Lesquereux. 4to. Cambridge, 1878.

——. The Auriferous Gravels of the Sierra Nevada of California. By J. D. Whitney. 4to. Cambridge, 1879–80.

Cambridge (Mass.). The Climatic Changes of later Geological Times: a discussion based on observations made in the Cordilleras of North America. By J. D. Whitney. 4to. Cambridge, 1880.

[Presented by Prof. J. D. Whitney.]

Canada. Geological Survey: Report of Progress from commencement to 1863, accompanied by Atlas. 8vo. Montreal, 1863–65.

——. Report of Progress from 1866 to 1869. 8vo. Montreal, 1870.

——. Do. do. 1870–71. 8vo. Ottawa, 1872.

——. Do. do. 1871–72. 8vo. Montreal, 1872.

——. Do. do. 1872–73. 8vo. „ 1873.

——. Do. do. 1873–74. 8vo. „ 1874.

——. Do. do. 1874–75. 8vo. „ 1876.

——. Do. do. 1875–76. 8vo. „ 1877.

[Presented by the Misses Courtney.]

Cornwall, Devon, &c. Report on the Inspection of Metalliferous Mines in Cornwall, Devonshire, Dorsetshire, and part of Somersetshire, for the year ended 31st December, 1874. By Clement Le Neve Foster, B.A, D.SC., F.G.S. Folio.

——. Ditto, for the year ended 31st December, 1879. By Clement Le Neve Foster, B.A., D.SC., F.G.S. Folio.

——. Joint Report of Messrs. C. Le Neve Foster and R. J. Frecheville, on the Inspection of Metalliferous Mines in Cornwall, Devonshire, Dorsetshire, and part of Somersetshire, for the year ended 31st December, 1880. Folio. (Two copies.)

[Presented by Dr. C. Le Neve Foster and Mr. R. J. Frecheville.]

Falmouth. Miners' Association of Cornwall and Devon. Reports and Proceedings for the years 1872–73 and 1879. 8vo. Truro, Falmouth, 1873, 1880.

——. Royal Cornwall Polytechnic Society. Forty-eighth Annual Report, 1880. 8vo. Falmouth [1881].

Truro. Royal Institution of Cornwall. Journal and Report, No. xxiii., March, 1881. 8vo. Truro, 1881.

Dorpat. Dorpater Naturforscher-Gesellschaft. Archiv für die Naturkunde Liv- Ehst- und Kurlands.

Dorpat. I. Serie.—Mineralogische Wissenschaften, nebst Chemie, Physik und Erdbeschreibung. Band vii., title-page.

——. II. Serie.—Biologische Naturkunde. Band ix., pp. 1–236. 8vo. Dorpat, 1880.

——. Sitzungsberichte. V. Band, Heft 3. 12mo. Dorpat, 1881.

Edinburgh. Edinburgh Geological Society. Transactions: Vol. iv., part i. 8vo. Edinburgh, 1881.

——. Edinburgh Museum of Science and Art. Analytical Index of the Mineral Collection. By Professor Thomas C. Archer, Director. 8vo. Edinburgh, 1871.

——. Catalogue of the Mineral Collection. By Professor Thomas C. Archer, Director. 8vo. Edinburgh, 1877.

[Presented by Professor Archer.]

——. Royal Society of Edinburgh. Proceedings: Vol. x., pp. 315 to end, 1879–80. 8vo. Edinburgh, 1880.

India. Geological Survey of India.

——. Memoirs: Vol. xvi., parts 2, 3. 8vo. Calcutta, 1880.

——. Palæontologia Indica:

Fossil Flora of Gondwanas, vol. iii., part 2. 4to. Calcutta, 1880.

Index to „ vol. i. „ „ „

Index to „ vol. ii. „ „ „

Fossil Flora of Gondwanas. Supplemental vol. iii., part 1. 4to. Calcutta, 1881.

——. Records: Vol. xiii., parts 3, 4. 8vo. Calcutta, 1880.

——. „ „ xiv., part 1. „ „ 1881.

Leicester Literary and Philosophical Society. Transactions: Part 7, June, 1860, to June, 1865. 8vo. Leicester, 1881.

——. Report of the Council and Transactions for 1880–81. 8vo. Leicester, 1881.

Liége. Sociétié Géologique de Belgique. Annales: Tome vi., 1878–79. 8vo. Liége, 1879.

Liverpool. Literary and Philosophical Society of Liverpool. Proceedings: Vol. xxxiii., 1878–79; vol. xxxiv., 1879–80. 8vo. Liverpool, 1879–80.

London. British Association for the Advancement of Science. Swansea Meeting, 1880. Report. 8vo. London, 1880.

London, Edinburgh, and Dublin Philosophical Magazine:
No. 64, vol. x., series V.
„ 65–71, vol. xi., series V.
„ 72–76, vol. xii. „ 8vo. London, 1880–81. *Purchased.*

——. Geologists' Association. Additions to Library in 1880. Index and title-page of vol. vi., 1879–80. Proceedings: Nos. 8, 9, vol. vi.; Nos. 1, 2, vol. vii. 8vo. London, 1880–81.

——. Geological Society. Abstracts of Proceedings. List of Officers and Fellows, November 1st, 1880. Quarterly Journal: Vol. xxxvi., part 4; xxxvii., parts 1, 2, 3. 8vo. London, 1880–81.

——. Palæontographical Society. Publications: Vol. xxxv., 1881. 4to. London, 1881. *Purchased.*

——. Royal Society. Proceedings:
Nos. 207–211, vol. xxxi.
„ 212–215 „ xxxii. 8vo. London, 1880–81.

Manchester. Manchester Geological Society. Transactions: Vol. xvi., parts 1–8. 8vo. Salford, 1880–81.

——. Manchester Scientific Students' Association. Report and Proceedings for the year 1880. 8vo. n.p., 1881.

New South Wales. Department of Mines. Annual Reports for the years 1878–79, with accompanying Maps. 4to. Sydney, 1879–80.

——. Royal Society. Journal and Proceedings:
Vol. xiii., 1879. 8vo. Sydney, 1880.
Vol. xiv., 1880. 8vo. Sydney, 1881.

Norwich. Norwich Geological Society. Proceedings: Vol. i., parts 1–5. 8vo. Norwich, 1878–81.

Ouro Preto. Annales da Escola de Minas de Ouro Preto: No. 1. 8vo. Rio de Janeiro, 1881.

Paris. Annales des Mines:
Série VII., tome xviii., liv. 4–6.
„ „ „ xix. „ 1–3. 8vo. Paris, 1880–81.

Penzance. Penzance Natural History and Antiquarian Society. Objects and Laws, with Lists of the Officers and Members for the year 1880–81; Report and Proceedings, 1880–81. 8vo. Penzance—Plymouth, 1880–81.

Philadelphia. Academy of Natural Sciences. Proceedings: Parts 1–3, 1880. 8vo. Philadelphia, 1880.

——. American Philosophical Society.

——. Proceedings: Vol. xviii., No. 106. 8vo. Philadelphia, 1880.

——. „ Vol. xix., Nos. 107, 108. 8vo. Philadelphia, 1880–81.

——. Transactions: New Series, vol. xv., part 3. Folio. Philadelphia. 1881.

——. List of Members: March 15th, 1880. 8vo. Philadelphia. 1880.

Pisa. Atti della Società Toscana di Scienze Naturali. Vol. iv., fasc. 2°. Pisa, 1880.

——. Processi verbali. Pisa, 1880–81.

Plymouth Institution, and Devon and Cornwall Natural History Society. Report and Transactions: Vol. vii., part 3, 1880–81. 8vo. Plymouth, 1881.

Rio de Janeiro. Archivos do Museu Nacional do Rio de Janeiro. Vol. iii., 3° e 4° Trimestres. 4° Rio de Janeiro, 1878.

United States. A Sketch of the Origin and Progress of the United States Geological and Geographical Survey of the Territories. 8vo. Washington, 1877.

[Presented by Dr. F. V. Hayden.]

——. Preliminary Report of the Field-work of the United States Geological and Geographical Survey of the Territories, for the season of 1877. 8vo. Washington, 1877.

——. The following papers extracted from "Palæontological Bulletin:"

1. On some New or little-known Reptiles and Fishes of the Cretaceous No. 3 of Kansas. By E. D. Cope. 8vo. 1877.
2. Descriptions of Extinct Vertebrata from the Permian and Triassic Formations of the United States. By E. D. Cope. 8vo. 1877.
3. On Reptilian Remains from the Dakota Beds of Colorado. By E. D. Cope. 8vo. 1877.
4. Descriptions of New Vertebrata from the Upper Tertiary Formations of the West. By E. D. Cope. 8vo. 1877.

London, Edinburgh, and Dublin Philosophical Magazine:
No. 64, vol. x., series V.
„ 65–71, vol. xi., series V.
„ 72–76, vol. xii. „ 8vo. London, 1880–81. *Purchased.*

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Nos. 207–211, vol. xxxi.
„ 212–215 „ xxxii. 8vo. London, 1880–81.

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Vol. xiv., 1880. 8vo. Sydney, 1881.

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——. Proceedings: Vol. xviii., No. 106. 8vo. Philadelphia, 1880.

——. „ Vol. xix., Nos. 107, 108. 8vo. Philadelphia, 1880–81.

——. Transactions: New Series, vol. xv., part 3. Folio. Philadelphia. 1881.

——. List of Members: March 15th, 1880. 8vo. Philadelphia. 1880.

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——. Processi verbali. Pisa, 1880–81.

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2. Descriptions of Extinct Vertebrata from the Permian and Triassic Formations of the United States. By E. D. Cope. 8vo. 1877.
3. On Reptilian Remains from the Dakota Beds of Colorado. By E. D. Cope. 8vo. 1877.
4. Descriptions of New Vertebrata from the Upper Tertiary Formations of the West. By E. D. Cope. 8vo. 1877.

5. On some Saurians found in the Triassic of Pennsylvania, by C. M. Wheatley. By E. D. Cope. 8vo. 1877.
6. On the Vertebrata of the Dakota Epoch of Colorado. By E. D. Cope. 8vo. 1877.
7. Verbal Communication on a New Locality of the Green River Shales, containing Fishes, Insects, and Plants in a good state of preservation. By E. D. Cope. 8vo. 1877.
8. On a New Species of Adocidæ from the Tertiary of Georgia. By E. D. Cope. 8vo. 1877.
9. On a Gigantic Saurian from the Dakota Epoch of Colorado. By E. D. Cope. 8vo. 1877.
10. Descriptions of Extinct Batrachia and Reptilia from the Permian Formation of Texas. By E. D. Cope. 8vo. 1878.
11. On some of the Characters of the Miocene Fauna of Oregon. By E. D. Cope. 8vo. 1878.

On the Genera of Felidæ and Canidæ. By E. D. Cope. 8vo. 1879.

The Relations of the Horizons of Extinct Vertebrata of Europe and North America.

Observations on the Faunæ of the Miocene Tertiaries of Oregon. By E. D. Cope. 8vo. 1879.

Fossil Forests of the Volcanic Tertiary Formations of the Yellowstone National Park. By W. H. Holmes. 8vo. Washington, 1879.

The so-called Two-Ocean Pass. By F. V. Hayden. 8vo. Washington, 1879.

Additional Lists of Elevations. By Henry Gannett. 8vo. Washington, 1879.

Catalogue of the Publications of the United States Geological and Geographical Survey. 3rd Edition, revised to December 31st, 1878. 8vo. Washington, 1879.

On the Foramina Perforating the Posterior Part of the Squamosal Bone of the Mammalia. By E. D. Cope. 8vo. 1880.

A Review of the Modern Doctrine of Evolution. By E. D. Cope. 8vo. 1880.

On the Genera of the Creodonta. By E. D. Cope. 8vo. 1880.

The New West Illustrated. Vol. ii., No. 1. Omaha, Nebraska, January, 1880.

The Naturalists' Leisure Hour and Monthly Bulletin. No. 8., August, 1880. Sundry Leaflets. 8vo. Philadelphia.

United States. Bulletin of the United States Museum:

No. 12. Contributions to North American Ichthyology, No. 3.

(*a*) On the Distribution of the Fishes of the Alleghany Region of South Carolina, Georgia, and Tennessee, with descriptions of new or little-known species. By D. S. Jordan and A. W. Brayton.

(*b*) A Synopsis of the Family Catostomidæ. By D. S. Jordan. 8vo. Washington, 1878.

No. 13. The Flora of St. Croise and the Virgin Islands. By Baron H. F. A. Eggers. 8vo. Washington, 1879.

No. 14. Catalogue of Collection to Illustrate Animal Resources and the Fisheries of the United States, exhibited at Philadelphia in 1876 by the Smithsonian Institution and the United States Fish Commission, and forming a part of the United States National Museum. Prepared under the direction of G. Brown Goode. 8vo. Washington, 1879.

No. 15. Contributions to the Natural History of Arctic America, made in connection with the Howgate Polar Exhibition, 1877–78. By Ludwig Kumlien. 8vo. Washington, 1879.

No. 18. Exhibit of the Fisheries and Fish Culture of the United States of America, made at Berlin in 1880. Prepared under the direction of G. Brown Goode. 8vo. Washington, 1880.

——. Bulletin of the United States Geological and Geographical Survey of the Territories: Vol. v., No. 4. (Third instalment of Dr. Elliott Cones' "American Ornithographical Bibliography"), 8vo. Washington, 1880.

United States. Quarterly Report of the Chief [Joseph Nimmo, jun.] of the Bureau of Statistics . . . . relative to the Imports, Exports, Immigration, and Navigation of the United States for the three months ended September 30th, 1879. 8vo. Washington, 1880.

——. Ditto, for three months ended December 31st, 1879. 8vo. Washington, 1880.

——. Ditto, for three months ended March 31st, 1880. 8vo. Washington, 1880.

——. Ditto, for three months ended June 30th, 1880. 8vo. Washington, 1880.

——. Geological and Geographical Survey. Publications:

——. Synopsis of the Acrididæ of North America. By Cyrus Thomas. [Vol. v., Reports in 4to.] Washington, 1873.

——. Report on the Geology of the Eastern portion of the Uinta Mountains and a region of country adjacent thereto. With Atlas. By J. W. Powell. 4to. Washington, 1876.

——. Report on the Lands of the Arid Region of the United States, with a more detailed account of the lands of Utah. With maps. Second Edition. By J. W. Powell. 4to. Washington, 1879.

——. Report on the Geology of the High Plateaus of Utah. With Topographical and Geological Atlas. By Captain C. E. Dutton. Folio. New York—Washington, 1879–80.

——. Proceedings of the United States National Museum: Vol. ii., 1879. 8vo. Washington, 1880.

——. History of the North American Pinnipeds: a Monograph of the Walruses, Sea-lions, Sea-bears, and Seals of North America. By Joel Asaph Allen. [No. xii. of the Miscellaneous Publications.] 8vo. Washington, 1880.

Victoria. Mineral Statistics of Victoria for the years 1865, 1870–80. Folio. Melbourne, 1866, 1871–81.

——. Gold Fields Statistics of Victoria for the year 1863. Folio. Melbourne, 1864.

——. Reports of the Mining Surveyors and Registrars of Victoria for the quarters ended 30th June, 30th September, and 31st

December, 1872; 31st December, 1877; 30th September and 31st December, 1878; 30th September and 31st December, 1880, and 31st March, 1881. Folio. Melbourne, 1872–81.

Vienna. K. K. Geologische Reichsanstalt, Verhandlungen:
Nos. 12–18 (1880). 8vo. Vienna, 1880.
,, 1–7 (1881). 8vo. Vienna, 1881.

Washington. Smithsonian Institution. Annual Report of the Board of Regents for the year 1879. 8vo. Washington, 1880.

——. Contributions to Knowledge: Vol. xxiii. 4to. Washington, 1881.

——. Miscellaneous Collections: Vols. xviii., xix. 8vo. Washington, 1880.

——. Miscellaneous Collections: Vols. xx., xxi. 8vo. Washington, 1881.

——. A Memorial of Joseph Henry. Published by Order of Congress. 8vo. Washington, 1880.

Tulloch, Colonel Sir Alexander, and McNeill, The Right Hon. Sir John. The Crimean Commission and the Chelsea Board; being a Review of the Proceedings and Report of the Board. Second Edition. Published with reference to certain misstatements in Mr. Kinglake's sixth vol. With a Preface by the Right Hon. Sir John McNeill, G.C.B., and copies of the Addresses to the Commissioners. 8vo. London, 1880.

II. GEOLOGICAL AND MISCELLANEOUS BOOKS.

Presented by the Authors or purchased.

Attwood, George. Practical Blowpipe Assaying. 8vo. London, 1880. *Purchased.*

Cooke, Josiah Parsons. Contributions from the Chemical Laboratory of Harvard College. (From Proceedings of American Academy of Arts and Sciences, vol. xxvii., new series IX.). 8vo. Boston, May, 1881.

Delesse, Achille. Sur les Etudes de Géologie Agronomique aux Etats-Unis et en particulier sur celles de M. G. H. Cook, dans le New Jersey. 8vo. Paris, 1880.

Geinitz, H. B. Die Versteinerungen des Lithographischen Schiefers im Dresdener Museum. 8vo. [Dresden], 1881.

Hébert, M. Histoire Géologique du Canal de la Manche. (Extrait des comptes rendus des Séances de l'Académie des Sciences, t. xc.) 4to. Paris, 1880.

[Presented by Dr. C. Le Neve Foster.]

Macar, Julien. Bassin de Liége. Tracé des Failles et Allures de Couches. (Ex. Ann. Soc. Géol. de Belg., t. vi., plates 4–7.) 1880.

Pattison, S. R. A Geological Trip in Colorado in 1880. (Reprint from Proceedings of Geologists' Association, vol. vii., No. 2.) 8vo.

Pengelly, William. Notes on Boulders and Scratched Stones in South Devon, part 3. 8vo.

——. Notes on Recent Notices of the Geology and Palæontology of Devonshire, part 7. 8vo.

——. Sixteenth and Concluding Report of the Committee . . . appointed for the purpose of Exploring Kent's Cavern, Devonshire. (William Pengelly, F.R.S., Reporter.) 8vo. [1880.]

Reyer, Eduard. Allgemeine Geschichte des Zinnes. 8vo. Vienna, 1880.

——. Zinn; eine Geologisch-Montanistisch-Historische Monografie. 8vo. Berlin, 1881.

——. Geologie des Zinnes. 8vo. Vienna, 1881.

CURATOR'S REPORT.

THE following have been added to the Museum during the past year:

I. MINERALS.

	NAME AND LOCALITY.	DONOR.
1.	Quartz, Calcite, Blende, &c., Roman Gravels Mine	Arthur Waters.
2.	Crystallized Sulphur, Giona Mines, Racalmuto, Sicily . . .	Bernard Le Neve Foster.
3.	Small Garnets and Rubies, Stream bottoms, Surinam . . .	W. B. Lord, per Thos. Cornish.
4.	"Pea" Iron Ore, Lake bottoms, Sweden	" "
5.	Native Copper, Island of Michipicoten, Lake Superior	W. Fraser Rae.
6.	Argentiferous Galena, Terrible Lode, Clear Creek County, Colorado . .	" "
7.	Senarmontite, Algeria . . .	*Purchased.*
8.	Iodyrite (Silver Iodide), Leadville, Colorado	John R. Roberts, per Thos. Cornish.
9.	Iron Pyrites (washed out of Quartz matrix), Johanngeorgenstadt . .	W. Ambrose Taylor.
11.	Asbolan (Earthy Cobalt Ore), Foel Hiraddug Mine, Cwm, Rhyl . .	M. A. Gage, per Dr. Foster.
12.	Cobalt Ore (as sent to smelters), Foel Hiraddug Mine, Cwm, Rhyl . .	" "
13.	Brown Iron Ore (pseudomorphous, after Iron Pyrites; found in the Cobalt lode). Foel Hiraddug Mine, Cwm, Rhyl .	" "
14.	Brown Hæmatite (picked out from the Cobalt Ore), Foel Hiraddug Mine, Cwm, Rhyl	" "

II. ROCKS.

1.	Basalt, Mahé Island, Seychelles, Japan . . .	H. B. Guppy.
2.	Granite " " " . . .	"
3.	" " " " . . .	"

	NAME AND LOCALITY.	DONOR.
4.	Granite, Mahé Island, Seychelles, Japan . .	H. B. Guppy.
5.	„ „ „ „ . . .	„
6.	Dolerite „ „ „ . . .	„
7.	Felspathic Trap, Nagasaki	„
8.	„ „	„
9.	Trachyte „	„
10.	Mica Schist „	„
11.	„ „	„
12.	„ „	„
13.	Felsitic Trap „	„
14.	„ „	„
15.	Porphyritic Trachyte, Nagasaki . . .	„
16.	„ „ . . .	„
17.	Altered Mica Schist „ . . .	„
18.	Quartz (? and Lepidolite) „ . . .	„
19.	Porphyritic Trap „ . . .	„
20.	Trap Rock (from a dike) „ . . .	„
21.	Trachyte „ (Tokeet's Road) .	„
22.	„ „ „ .	„
23.	„ „ „ .	„
24.	„ „ „ .	„
25.	„ „ „ .	„
26.	Trachytic Rock (spheroidal and concretionary structure), Nagasaki (Tokeet's Road) . . .	„
27.	Basalt, Nagasaki (near Tokeet's) . . .	„
28.	Quartz-Porphyry, Nakasaki (near Tokeet's) . .	„
29.	Phonolite „ „ . .	„
30.	Trachytic Rock „ (near Giant's Head, Tokeet's)	„
31.	Limestone Conglomerate, Two-Sima, Nagasaki . .	„
32.	Calcareous Sandstone „ „ . .	„
33.	„ „ „ „ . .	„
34.	Sandstone „ „ . .	„
35.	Compact Limestone „ „ . .	„
36.	Dark-coloured Shale „ „ . .	„
37.	„ „ „ „ . .	„
38.	Sanidine Porphyry, Mogi, Nagasaki . . .	„
39.	Veinstone „ „ . . .	„
40.	Volcanic Tufa „ „ . . .	„
41.	„ (from a bed between leaf-bearing shales), Mogi, Nagasaki	„
42.	Mica-Schist, Mogi, Nagasaki	„
43.	„ „ „	„
44.	„ (with Chlorite), Mogi, Nagasaki . .	„

	NAME AND LOCALITY.	DONOR.
45.	Trachyte, Mogi, Nagasaki	H. B. Guppy.
46.	„ near Mogi, Nagasaki . . .	„
47.	Basalt (from a columnar dike), Mogi, Nagasaki .	„
48.	Volcanic Tufa, Mogi Bay, Nagasaki . . .	„
49.	Sandstone, Mogi Leaf-beds, Nagasaki . . .	„
50.	Shale „ „ „ . . .	„
51.	Sandstone, Omura, Nagasaki	„
52.	Phonolite „ „	„
53.	Pitch Stone „ „	„
54.	Quartzite, near Nagasaki	„
55.	Felsite „	„
56.	„ „	„
57.	„ „	„
58.	Felsitic Trap „	„
59.	„ „	„
60.	Porphyritic Rock, near Nagasaki . . .	„
61.	Porphyritic Melaphyre „ . . .	„
62.	Melaphyre „ . . .	„
63.	Phonolite „ . . .	„
64.	Sanidine Trachyte „ . . .	„
65.	Trachyte „ . . .	„
66.	„ „ . . .	„
67.	„ „ . . .	„
68.	Sandstone „ . . .	„
69.	„ (decomposed) „ . . .	„
70.	Basalt „ . . .	„
71.	Mica-Schist „ . . .	„
72.	„ „ . . .	„
73.	Micaceous Rock „ . . .	„
74.	Granitoid Rock „ . . .	„
75.	„ „ . . .	„
76.	Granite, Kobé . . .	„
77.	Pumice, Sakura Island, Gulf of Kagosima . .	„
78.	„ „ „ . .	„
79.	Porphyritic Lava, Sakura Island, Gulf of Kagosima	„
80.	„ „ „ „ „ .	„
81.	Sanidine Porphyry, Unzen, Simabara . . .	„
82.	„ „ „ „ . . .	„
83.	„ „ „ „ . . .	„
84.	„ „ (altered by proximity to hot springs), Unzen, Simabara . . .	„
85.	„ „ (with Hornblende), Unzen, Simabara	„
86.	Felspathic Rock (from hot springs) „ „ .	„

	NAME AND LOCALITY.	DONOR.
87.	Felspathic Trap, Simabara	H. B. Guppy.
88.	Granite (altered), Chusan	„
89.	„ „ „	„
90.	Quartz-Porphyry, Hisakajima, Goto Archipelago .	„
91.	Felspar-Porphyry „ „ .	„
92.	Felsite (? Sandstone) „ „ .	„
93.	Micaceous Shale „ „ .	„
94.	Granite Rock „ „ .	„
95.	„ „ „ „ .	„
96.	Quartzite „ „ .	„
97.	„ „ „ .	„
98.	„ „ „ .	„
99.	Micaceous Argillaceous Sandstone, Naru-Sima, Goto Archipelago	„
100.	Quartz-Porphyry, with Quartz Crystals, Naru-Sima, Goto Archipelago	„
101.	Quartz-Porphyry, Naru-Sima, Goto Archipelago .	„
102.	Felsite „ „ „ .	„
103.	„ „ „ „ .	„
104.	Basaltic Lava „ „ „ .	„
105.	Melaphyre, Island of Kashira-Jima, Goto Archipelago	„
106.	Sandstone „ „ „ „	„
107.	„ (laminated) „ „ „	„
108.	Felsitic Basalt, Yebukuro Harbour, Hirado Island .	„
109.	„ (with Olivine) „ „ .	„
110.	„ „ „ „ .	„
111.	„ „ „ „ .	„
112.	Basaltic Lava „ „ .	„
113.	„ (decomposed) „ „ .	„
114.	Basaltic Tufa „ „ .	„
115.	Blue Basalt „ „ .	„
116.	Volcanic Agglomerate „ „ .	„
117.	Volcanic Tufa „ „ .	„
118.	Sandstone, Kawachi, Hirado Island . . .	„
119.	„ „ „ . . .	„
120.	Basalt „ „ . . .	„
121.	Phonolite „ „ . . .	„
122.	„ „ „ . . .	„
123.	Porphyrite, Snowy Valley, Ningpo . . .	„
124.	„ „ „ . . .	„
125.	Felsitic Rock, near Ningpo	„
126.	Felstone-Porphyry „	„
127.	Felstone „	„

	NAME AND LOCALITY.	DONOR.
128.	Felstone, near Ningpo	H. B. Guppy.
129.	Felsite (amygdaloidal), near Ningpo . . .	„
130.	Crystalline Limestone, Chefoo . . .	„
131.	Limestone (metamorphic) „ . . .	„
132.	Mica-Schist „ . . .	„
133.	„ „ . . .	„
134.	„ „ . . .	„
135.	„ „ . . .	„
136.	„ „ . . .	„
137.	„ „ . . .	„
138.	„ „ . . .	„
139.	„ „ . . .	„
140.	„ „ . . .	„
141.	„ „ . . .	„
142.	Quartz-Schist, with a little Mica, Chefoo . .	„
143.	Quartz Rock, Chefoo	„
144.	„ „	„
145.	Calcareous Concretion, near Chefoo . . .	„
146.	„ „ „ . . .	„
147.	Granite (decomposed), Amoy . . .	„
148.	Granite, Nankow Pass	„
149.	Limestone „	„
150.	„ „	„
151.	„ „	„
152.	Basalt „	„
153.	Greisen, Mackan Island, Corean Archipelago . .	„
154.	„ „ „ „ . .	„
155.	Gneiss „ „ „ . .	„
156.	„ „ „ „ . .	„
157.	Gneissic Rock „ „ „ . .	„
158.	„ „ „ „ . .	„
159.	Quartzite „ „ „ . .	„
160.	Quartz Rock „ „ „ . .	„
161.	Quartz (with Iron Pyrites altered to Limonite, Mackan Island, Corean Archipelago . . .	„
162.	Micaceous Rock, Mackan Island, Corean Archipelago	„
163.	Felsite, Pootoo Island, Chusan Archipelago . .	„
164.	Limestone, near Hankow	„
165.	Calcareous Micaceous Sandstone, near Hankow .	„
166.	Quartz Rock, near Hankow	„
167.	Quartzite Sandstone „	„
168.	Conglomerate, Hanyang Hill, Hankow . .	„
169.	„ „ „ . .	„

NAME AND LOCALITY.	DONOR.
170. Mica Schist, Kinkiang	H. B. Guppy.
171. Granite Rock „	„
172. ? Black Chert „	„
173. Felsite, Namoa Island	„
174. Amygdaloid (with nodules of Hematite), Pescadores Islands	„
175. Amygdaloid (?) with Calc-Spar, Pescadores Islands .	„
176. Basalt, Pescadores Islands	„

FOSSILS.

1–22. Sundry Fossils, including *pecten*, *spatangus*, cast of spiral univalve, markings of fossil leaves, &c., from Two-Sima, Mogi, and Tackow . . .	„

TREASURER'S STATEMENT, 1880-81.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

RECEIPTS.	£	s.	d.
To Balance	59	7	5
,, Donation from H.R.H. the Prince of Wales	20	0	0
,, Ordinary Subscriptions and Arrears	85	1	0
,, Sale of *Transactions*	13	3	0
	£177	11	5

EXPENDITURE.	£	s.	d.
By Rates and Taxes	0	8	0
,, Housekeeper	6	10	0
,, Insurance	2	12	9
,, Subscription Palæontographical Society	1	1	0
,, Printing, Books, and Stationery	22	14	9
,, Assistant Curator	21	0	0
,, Ditto, Donation	5	0	0
,, Sundry Bills	6	16	10
,, Expenses per Secretary and Treasurer	13	5	4
,, Gas Fittings	11	7	6
Balance forward	86	15	3
	£177	11	5

W. BOLITHO, JUN.,
Treasurer.

Nov. 5th, 1881.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

NOVEMBER 4th, 1881.

1. The Duchy Peru Lode, Perranzabuloe. By Warington Smyth, M.A., F.R.S., F.G.S.

2. Description of Besshi Copper Mine, in Japan. By R. J. Frecheville.

3. On the Occurrence of Cobalt Ore in Flintshire. By C. Le Neve Foster.

4. The Evidence of Glacial Action in Cornwall and Devon. By Nicholas Whitley, C.E.

5. On a New Method of Ventilating Ends by Compressed Air. By Wm. Teague, jun., Assoc. Inst. C.E.

ON THE OCCURRENCE OF COBALT ORE IN FLINTSHIRE.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

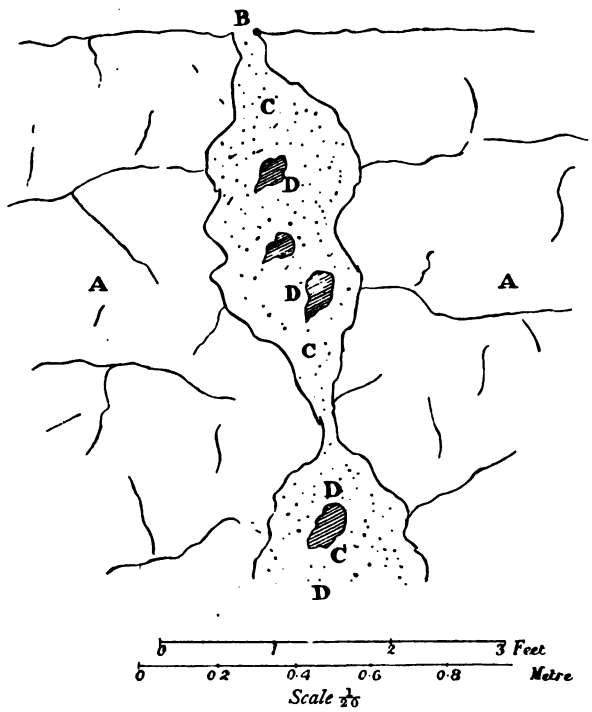
During the last few years cobalt ore has been obtained from Foel Hiraddug Mine, in the parish of Cwm, near Rhyl.

The ore occurs in the Carboniferous Limestone, which seems to have furnished a good deal of iron ore from shallow pockets, if one may judge by the numerous pits scattered about near the mine.

It was in working one of these pockets that Mr. Gage made the discovery of the cobalt. He happened to notice some black strings in the limestone, and on testing them with the blowpipe he ascertained that the black colour was due to oxide of manganese in some cases, and to oxide of cobalt in others. On further examination of the pit, Mr. Gage discovered a vein of cobalt ore, which has now been worked continuously on a small scale for several years.

The vein runs in a general N.N.E. direction, and has a varying dip, sometimes to the east, and sometimes to the west, whilst very often it is nearly perpendicular. On the whole it is extremely irregular. The accompanying sketch will give a better idea

of its general character than a mere verbal description.



AA, grey crystalline limestone; BB, vein of cobalt ore, composed of red clay, CC, and loose fragments of limestone, DD. The clay contains small lumps of brown hæmatite, and black grains of wad and asbolane, or earthy cobalt ore. Occasionally lumps of asbolane, as big as walnuts, or even hen's eggs, are met with. These pieces of ore often exhibit a reniform or botryoidal structure; they are black in colour, soft enough to mark paper, and give a shining black streak upon porcelain. Their chemical composition is by no means uniform, as will be seen from the ac-

companying analysis, made by Mr. Gage. The pieces of ore were carefully cleaned from all adhering clay, and then dried at 212° F. before being analysed.

	1	2	3
Cobalt sesquioxide, $Co_2 O_3$ . .	37·40	20·63	26·20
Nickel sesquioxide, $Ni_2 O_3$. .	8·58	6·85	10·35
Manganese binoxide, $Mn O_2$.	23·12	39·50	25·58
Iron sesquioxide, $Fe_2 O_3$ . .	13·85	15·10	21·10
Copper oxide	traces	traces	0·25
Silica	0·45	2·00	0·60
Alumina	0·10	0·50	0·18
Water	16·00	15·00	15·00
	99·50	99·58	99·26

The Flintshire asbolane is remarkable for the large amount of nickel it contains.

The width of the vein varies from nothing to 8 or 10 feet, and it widens out and becomes pinched up very suddenly. The ordinary width does not exceed a foot. The walls are extremely irregular, as shown in the figure, and the cavity containing the ore has all the appearance of having been eaten out by water.

The mine has been worked to a depth of about 240 feet, the shoot of ore being followed by a series of *winzes* and irregular passages. The whole of the vein is not necessarily cobaltiferous; in fact, where it reached a width of 10 feet there was nothing but red clay without any cobalt. The only guide for the

miner is the streak upon porcelain. A little of the clay is taken and drawn over a piece of unglazed porcelain with the flat side of the blade of a knife; if a series of black shining streaks are formed, the miner concludes that cobalt is present, and the ore is saved; but as the streaks may be caused by particles of non-cobaltiferous wad, the value of the ore can only be definitely determined by chemical analysis.

On the whole the shoot, or ore-bearing part of the vein, dips to the North, and its horizontal length is about 20 or 30 yards. A second vein also has been discovered by Mr. Gage, and a trial has been made upon it to a depth of 90 or 100 feet.

The only preparation of the ore at the surface consists in picking out the numerous lumps of brown iron ore, and occasional fragments of limestone.

The ore sent to the smelters in Swansea contains but a small percentage of metal, as will be evident from the accompanying assays of five parcels.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Metallic cobalt . .	1·0	1·1	1·2	1·6	1·8
Metallic nickel . .	0·4	1·1	1·0	0·7	0·8
Total cobalt and nickel .	1·4	2·2	2·2	2·3	2·6

Strong traces of titanium have been found by Mr. Gage in some of the parcels of ore.

The amounts of ore sold have been as follows:

Year.		Tons.	Cwt.		Value. £	s.	d.
1878	.....	98	18	.....	616	17	0
1879	.....	116	11	.....	833	2	5
1880	.....	49	3	.....	297	6	4
	Total	264	12		£1747	5	9

The value of the ore per ton has therefore been on an average about £6 12s.

The mode of formation of the cobalt vein is a matter concerning which I have not been able to make up my mind. I have already said that the cavity between the two walls shows evidence of watery action, and it is probably merely a joint widened out by the long continued action of water charged with carbonic acid. The source of the cobalt is uncertain. Mr. Gage considers that it has been derived from the decomposition of cobaltiferous iron pyrites, and in confirmation of this view he showed me a large lump of brown iron ore which still contains a core of undecomposed pyrites. This lump was found in the lode at a depth of 30 feet from the surface; the pyrites has been analysed, and shows traces of cobalt and copper. Brown iron ore pseudomorphous after iron pyrites has also been found in the lode, and a very perfect little specimen has been presented to the Society by Mr. Gage. I noticed many such pseudomorphs among pieces of brown iron ore lying at the surface. These are reasons, therefore, for supposing that the present vein is the

gossan, or decomposed upper part of a lode of cobaltiferous iron pyrites. It is possible that the manganese may have been derived from the limestone; for on making an analysis of the *country*, Mr. Gage discovered that it contained about $\frac{1}{50}$ per cent, or 2 parts in 10,000, of oxide of manganese. Of course it might be objected that the manganese had found its way from the lode into the adjacent rock; but, on the other hand, it is well known that small quantities of manganese do occur in limestone occasionally; and I may here remark that the blowpipe reveals the presence of that metal in some of the limestone of the Great Orme's Head.

In conclusion, I desire to express my best thanks to Mr. Gage for the large amount of valuable information which he has placed at my disposal; and, as an incentive to the study of blowpipe analysis, I wish to place the fact upon record that Foel Hiraddug Mine, the only cobalt mine now worked in the British Isles, owes its existence as such entirely to his knowledge of this useful art.

DESCRIPTION OF BESSHI COPPER MINE, IN JAPAN.

By R. J. Frecheville.

In the spring of 1875 I was instructed by the Japanese Government, in whose service I at that time was as a mining and metallurgical engineer, to examine and report on the mineral resources of the island of Shikoku, and have thought that a brief description of one of the mines then visited by me would not be devoid of interest to the members of this Society.

As a prelude, however, it may not be out of place to bring to your recollection the position of the island of Shikoku, or, as it is written on our maps, Sikok.

The archipelago called by us Japan, but by its inhabitants Dai-Nippon, consists of 3,800 islands, of which the four principal ones are Yesso, Hondo, Kiusiu, and Shikoku. The latter, which has a superficies about equal to that of Wales, lies to the S.E. of the main island called Hondo, and is separated from it by a narrow sheet of water known as the inland sea.

The rocks of which Shikoku is composed are amongst the most ancient to be found in the whole

of the Mikado's empire, which, though old in story, is, geologically speaking, a very young country.

The "Besshi Copper Mine," which forms the subject of the present sketch, is situated in the north-western part of the island, some ten miles to the south of the port of Nihama. The road connecting the mine with this place, for a distance of four miles, is a tolerably fair one, and passes over a flat country covered with fertile rice fields, and supporting a numerous population; for the last six miles it is only practicable for foot passengers; and passing through gorges and over steep ascents, climbs continuously until the summit of the mountain, which is about 4,250 feet above sea level, is gained.

The formation of the district in which the Besshi vein occurs consists of altered clay slates, such as hornblende and mica schists, alternating with beds of quartzite, the whole intersected by large masses of greenstone and serpentine.

Dislocation, faulting, and intense metamorphism, together with the absence of vegetation in the neighbourhood of the mine, caused by the trees having been cut down for the purpose of making charcoal, and the fumes from the smelting furnaces and roasting kilns, have combined to give an especially rugged and precipitous character to the topography of the region, the effect of which was heightened by the green fields of waving rice in the distance, and the blue waters of the inland sea studded with islands.

The "Besshi vein" crops out on the southern

side of the mountain, a few hundred yards below its summit; it occurs in mica-schist, this rock forming both its foot and hanging wall. The course of the vein coincides with the trend of the mountain range, that is, about N.W. and S.E., and it dips to the N.E. at an almost uniform angle of 50° from the horizontal. Its thickness varies, as observed in the workings, from 1 to 10 feet, the average being perhaps 5 feet. The filling of the vein is for the most part a solid compact mass of ore from wall to wall, consisting of an intimate mixture of copper and iron pyrites, varying in quality from a very low grade (such as to render its mining and smelting unprofitable) up to ore that yields over 23 per cent. of copper.

The mine has been in constant operation for nearly 200 years, so that the extent of the workings is considerable. The deepest adit has been driven in from the northern side of the mountain, and cuts the vein at a vertical depth of about 70 fathoms below its outcrop. All work and explorations at the time of my visit were, however, being carried on from an adit which has been driven in from the southern side of the mountain, at about 10 fathoms shallower level.

The deepest point attained by the workings was about 120 fathoms perpendicular below the level of the deep adit, the water being lifted to this height solely by hand pumps, of which there were 150, each pump consisting of a square wooden pipe, open at top and bottom, from 11 to 12 feet long, and about 5″ square inside, furnished with a clack valve, and a

piston packed with leather, worked directly by the hand.

The length that the vein was developed in the direction of its course was about 400 fathoms, the ore varying much in quality, but no unproductive ground has been encountered within this distance.

The ore ground made to the S.E., and the appearance of the stopes in the bottom part of the mine, were very promising—seven samples of ore, taken by myself at different places, giving on assay an average of 19 per cent. of copper.

The mine is worked by a series of underhand stopes, following down and extracting only the "richer shoots" and "bunches of ore," large bodies of ore assaying from 1½ to 3 per cent. of copper being left standing. The travelling roads consist of drifts or galleries, sometimes going down with the underlie, and sometimes diagonally, with steps cut into the foot wall of the lode, and in places rude ladders formed by the trunk of a tree with notches cut in it. The workings are closely packed with timber and attle. The ore undergoes a partial sorting underground, and is then transported in straw bags from all parts of the mine on the backs of men and boys to surface, the load being from 50 to 80 lbs. This is killing work, the roads being tortuous, narrow, and small, and the ventilation fearfully bad. Single-handed boring is in vogue, and gunpowder, which came into use about twenty-five years ago, is the explosive employed; vegetable oil, burnt in lamps made from shells, is used for illuminating purposes. The

heat underground was excessive; this was in great part due to the decomposition of the iron and copper pyrites of the lode, giving rise to the formation of sulphates of iron and copper, crystals of which could everywhere be seen coating the walls, and the attle on the stulls. All the pools of water in the levels were of a deep blue colour, owing to the presence of sulphate of copper. At the adit level, where the water flowed out of the mine, it contained so much of this salt in solution that it instantaneously coated with copper the blade of a knife dipped in it. I advised the precipitation of the copper by means of scrap iron, which process was at once adopted.

The ore having arrived at the surface, is carefully picked over by hand, and about twenty tons per day were being sent to the roasting kilns and smelting furnaces, situated some little distance further down the side of the mountain. In this transportation every advantage is taken of the force of gravity; cars, running on tramways with iron rails, convey the ore to certain points, from which, by means of "chutes" made of stout planks, about 18″ square section inside, supported sometimes on the side of the mountain, and sometimes on trestle work, and in one case by the aid of a self-acting rope tramway, carrying straw bags holding from 200 to 300 lbs., the ore finally reaches its destination, and is charged into kilns about five feet square and four feet deep, the walls rudely built of stone lined with clay, where it undergoes the process of roasting, the operation lasting from twenty to thirty days.

From the kilns the roasted ore is taken to the furnaces for running into *matte*, which consist of shallow oval depressions in the ground lined with a mixture of clay and charcoal; their dimensions are 2′ long, by 1½′ wide, by 1′ 2″ deep. These furnaces are covered with a hood, which also serves as a chimney, and the blast is supplied at the back through clay tuyères by means of a couple of blowing machines worked by hand. The roasted ore and charcoal are charged together, as also a little mica-schist to serve for flux; the slag flows continuously, and contains only a trace of copper. When the furnace is full of *matte*, its surface is cleaned of slag and charcoal, and then cooled by sprinkling cold water on it, the resulting crusts of *matte* being removed in discs by means of an iron bar.

The *matte*, samples of which assayed 54% of copper, is broken up and run into coarse copper in similar furnaces, the only difference being that the tuyères are more inclined, and that a clay cover is moulded over the charge after it has been put in the hearth, an opening being left in front just sufficient to see and rake through. The metallic copper formed is removed in discs in the same manner as described for the *matte*, except that hot water is sprinkled over its surface to cool it. The capacity of one of these furnaces is about 4,200 lbs. of ore per day.

All the coarse copper produced is carried by coolies to the refining works at Tatskawa, situated at the base of the mountain on the road to Nihama.

The refining process consists in the fusion of the

coarse copper, together with charcoal, under a highly inclined blast in furnaces of the same sort, but a little larger than those described before. The "rosette" copper produced is broken in pieces and melted in crucibles, with the addition of about ·2% of lead. A piece of oak charcoal is then inserted beneath the surface of the molten metal. After the lapse of two or three minutes this is withdrawn, and the contents of the crucible are poured into moulds under hot water. These moulds are made of wood, and have a strong hempen cloth stretched over them. Great care is taken to maintain the water at a uniform temperature. The resulting tiles, or plates of dry copper, are 9″ long, 6″ wide, and about ⅜″ thick. They have a magnificent red colour, and in this state are sent to market.

This copper commands a high price for electro-telegraphic purposes, on account of its great purity.

The total consumption of charcoal amounts to about 70% of the weight of the ore.

At the time of my visit 44·64 tons of refined copper per month were being produced by this mine, at a total cost of £50 per ton, delivered in the open treaty port of Kobe; and as I have previously stated that about twenty tons of ore were being raised per day, it will be seen that the produce was about 8%.

THE DUCHY PERU LODE, PERRANZABULOE.

By Warington Smyth, M.A., F.R.S., F.G.S.

In the year 1858 I ventured to bring before the Society a brief account of the remarkable lode which extends from the northern extremity of Perran Sands towards the north of Newlyn Downs. Before that date too little attention had, as I thought, been drawn to a lode so powerful, and so exceptional in its character.

Dr. Borlase,* exactly a hundred years before, probably referred to this vein, when, stating that not one iron mine had as yet in Cornwall been worked "to effect," he added, in a note, that "Iron is found in the Parishes of Morvah, Piran-sand, &c." The fact of the occurrence of iron at the cliff extremity was indicated by De la Beche, in his geological map, before 1839, by the sign for Mars, and the unusual line of bearing of the lode was briefly adverted to by Mr. Henwood in his well-known description of the St. Agnes and Perranzabuloe district.†

Since the date of my paper, about which time I had the pleasure of introducing to the locality more

* Borlase, *Nat. Hist. Corn.* 1758.

† *Trans. Roy. Geol. Soc. Corn.* vol. v. p. 108.

than one eminent iron master, the district, divided as it is between several "lords," has been taken in hand by a number of successive parties of adventurers. A large amount of work has been done, with a success perhaps commensurate with the judgment which has been brought into play. And the results which have been obtained by active working in that portion long called the Duchy Peru Mine are so curious and instructive that I propose to describe some of them, which are notable examples of lode structure, and which indicate the danger of neglecting to learn to appreciate the vagaries of this class of mineral repository.

Taking our stand on the Duchy sett,* near the 60-inch pumping engine, which easily masters the water down to the present maximum depth of 70 fathoms, we look in the direction W.N.W. by N. across a bare and undulated country to the bold line of sand-hills a little to the north of the old church of St. Piran, and beyond to the south of the dark headland of Ligger Point. Along this "caunter" line we may see by horse-whims or engine-houses the marks of workings which have tested the lode, at intervals of a few hundred fathoms, over a length of two and a half miles from the Duchy engine-house to the sea cliff. First to the west comes the Great Retallack Mine; then after a heave to the south the Treamble Sett, in which large open-casts have been worked. Next on the west follows Mount and

* The mine formerly known as Duchy Peru is now termed simply the Duchy Mine.

actions Mr. Joseph Carne stated that about 1788 the first discovery of silver ore in Cornwall was made "in a mine in the parish of Perranzabuloe, which was in consequence dignified with the name of Mexico." This silver-bearing vein crosses through the iron lode in the Treamble workings, and does not appear to have been made out or followed up on the south side of them.

Subsequently another cross vein, to the east of Trelask, and worked for some time as Wheal Peru, produced a moderate quantity of very rich silvery ore, and appears to point for the western end of the Duchy Mine. In 1859–60 I examined some ore in and from a little cross vein at the Mount Mine, Trebisken, then working by Mr. Whitford of St. Columb, which was stated to be worth at the rate of £800 per ton. It, however, exhibited distinct sprigs of native silver amid the broken galena, and hence no value could attach to an assay unless one knew how the ore was sampled.* At the present time two north and south veins coming in from the north are to be seen in the Duchy Mine, having a very pronounced dip to the eastward, distinctly cutting through the iron lode, promising in appearance, but disappointing so far in their productiveness.

A cross lode is stated again to come in at the Deer Park, and in the same category may also be placed the famous lode of East Wheal Rose, wrought for a short life of twenty years with extraordinary profit.

* See, for the account of the year's raisings and sales, HENWOOD, *Trans. Roy. Geo. Soc. Corn.* vol. viii. p. 121.

Another remarkable product of the Perran lode is the zinc blende, which after being discovered first in Great Retallack, and yielding sometimes thousands of tons in a year, has of late made its appearance in astonishing masses at the Duchy Mine, to the extent of supplying as much as 900 tons per month for some time past.*

It may thus be seen that at a number of isolated points along several miles of this lode, metalliferous treasures of various kinds have been laid open; but an important question at once suggests itself, What is the nature of the lode between these points, and what clue have we, in the drivings of the present mines, as to the value of the intervening ground? I fear that much of the disappointment that has attended these as well as other workings, arises from ignorance of the true nature of a lode. Every Cornishman must know more or less the unstable or "bunchy" character of most of these deposits; but the descriptions, calculations, and diagrams of outsiders who have touched on these questions betray a sublime disregard to the real state of the case. I need scarcely refer to the disgraceful misrepresentations of the prospects of certain Cornish lodes which have been so rife for the last year or two, and with which it is

* Besides the preponderating minerals of iron—brown ore, and chalybite—small quantities of hæmatite and magnetite have been met with; among the sulphides, pyrites, copper pyrites, zinc blende, and galena; metallic salts, pyromorphite, melanterite, and copper vitriol; and among the silicates common garnet, and boldly crystallized hornblende of the radiated *strahlstein* character, have occurred in different parts of the lode, the latter especially in the Great Retallack Mine.

satisfactory to find only a very few Cornish names are connected. These misleading concoctions generally betray that belief in the uniformity of lodes throughout a long run, which has to be rudely shaken by an intimate acquaintance with them. And in the present instance the statements as to "practically inexhaustible" quantities, and the diagrammatic sections, showing the brown ore of iron plunging, as it were, into an illimitable sea of white spathic iron, are taken from *data* which are true at certain points, but require a much closer attention to facts if we would approximate nearer to the whole truth.

In my former paper I stated that a large proportion of the width of the lode was not occupied by iron ore. This has been confirmed by the more recent workings of the Duchy Mine, where Captain P. Argall, who has studied the phenomena closely, considers that the iron ore affects chiefly the foot-wall or lying-side of the lode, and the zinc-blende, when it occurs, rather the central portion. In every one of the mines it has been evident that a large portion of the filling is of a mechanical character; *i.e.* the effect of a disruption—not only of the killas, in order to form the original fissure, but also of the material of an already solidified lode. This was indicated by sharp, naturally-broken fragments, both of the irony ore and of quartz veinstone, some of which exhibited the pseudomorphous characters so fully set forth years ago by our late member, Mr. R. W. Fox, F.R.S., and commented upon by Sir C. Lemon, Bart., in his address to this Society in 1845. The fragments,

usually quite angular, are in some cases cemented by quartz, as where the "saddle" rock and others point out the back of the lode, between the Twelve Burrows and Rejourra, whilst throughout a large part of the excavations the cementing substance is a soft, more or less flucany, and very variable material, produced by the disintegration of the killas rock. Some of the specimens of pseudomorphous quartz I have only seen paralleled in the iron lode of Restormel, near Lostwithiel, where black lines on a whitish ground, sometimes intersecting at definite angles, show a rough resemblance to the rectilinear characters of Oriental writing, and testify to the former presence of large crystals of rhombohedral carbonates. *

This breccia, so frequently seen in the lodes of Cornwall on a comparatively small scale, is in some parts of the Perran lode of portentous dimensions: thus, at the 60 fathom level in the Duchy Mine, the lode, 10 to 12 fathoms in width (taken horizontally), where it inclines at an angle of about 50° to the south-west, appears to be one vast mass of this fragmentary material. In the earlier days of the adventure, but little attention was paid to this constituent of the lode. Some zinc-blende was found and raised from shallow workings, as well as a few tons of yellow copper ore, but under conditions not very apparent; and throughout the soft ground a granular pyrites was often dispersed, so easily decom-

* "On Breccia Lodes in Cornwall and Devon;" *vide* De la Beche, *Report*, 1839, p. 323. Fine examples of this kind being generally too poor to serve as ore, are often buried in the tips or burrows, and built into walls.

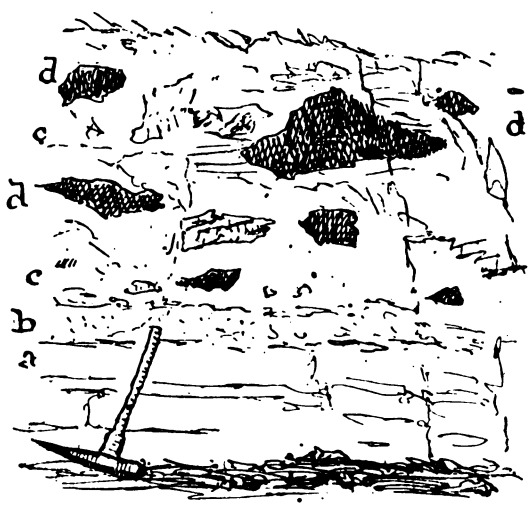
posable as to give rise to a very high temperature,* and to a coating of the walls with crystals and stalactites of various sulphates, especially melanterite, sometimes tinged blue by copper vitriol. At the 40, 50, and 60 fathom levels, fragments of zinc-blende form a valuable element in the breccia; pieces of all sizes, from the bigness of a nut to masses of several hundredweight, and even above a ton, lie enveloped in a soft bedding, and the singular spectacle is presented of levels and stopes being carried on for this mineral in the midst of a wash of material, requiring the greatest care in the setting and frequent renewal of the timbering.

The blende itself is peculiar for a mineral vein: the greater part of the lumps are dark brown massive granular zinc sulphide, mingled with disseminated iron pyrites, but without any of the quartz or spars or other substances that usually accompany it; and the question naturally arises, Whence did these fragments come? That question is now, up to a certain point, answered by the workings opened through the "Swansea" whim shaft down to the stopes above the thirty fathom level. Here, resting against crystalline quartz which belongs to the north or foot-wall, is the blende in a solid state, more or less jointed, but for some ten feet in width, and for many fathoms in length, comparatively unbroken. Hence it is that the fragments we had met with in the deeper levels must have fallen away; but how the great cavernous

* The temperature in the 60 cross-cut north was 82° F., when the external air was 52°, October 26th, 1881.

opening into which they fell was formed, and filled with the other ingredients of the lode, and to what depth this broken material is likely to extend, and by what it will be succeeded, are matters of speculation; and the practical results are only to be solved by miner-like trials.

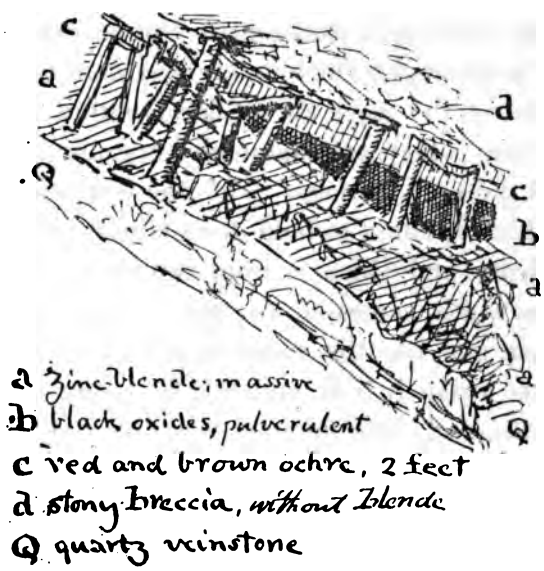
Meanwhile some other peculiarities are observable. The loose masses of blende are so often associated



with a white, friable, "pryany" substance, that the men generally look for the latter as a guide. Here and there deposits, lying almost flat, are met with, as for instance in the present hot cross-cut north of the sixty, where, next to the floor, is (*a*) a laminated gray clay-like substance, containing a small percentage of

lead; (*b*) six to ten inches of granular pyrites, not solid, but more or less mixed with clay, and quickly decomposing; (*c*) the breccia, with its fragments of zinc blende.

Other parts point to a great amount of decomposition having taken place before the access of air en-



abled the pyrites to produce its sulphates. In some of the shallow stopes there comes in, under the soft breccia (*d*), a bed of one to two feet thick of laminated red ochre (*c*), followed, underneath, by a powdery mass (*b*), from a few inches to two or three feet thick, of black oxide, in which copper, manganese, and zinc appear to be present, and this forms the upper side of the solid body of blende.

And now to return for a brief space to the hori-

zontal extension of these courses, shoots, or columns of ore. No one who had seen the masses of cellular brown oxide of iron (brown hæmatite) exhibited at most of these mines, or the extremely pure compact mineral of the same class, occurring at Berriman's shaft, Treamble, or the masses of solid blende which I have just described, would be prepared to find these minerals wanting in continuity. But an examination of the levels at the Duchy mine will show that a termination of the most abrupt kind, within the walls of the lode (which are commonly very obscure), often bounds the orey portions. The fine course of chalybite, which is found to hold down almost vertically to the seventy, and which is from two to three fathoms in cross width, comes to an end suddenly both east and west, and has the peculiarity that the "heads" or joints strike N.N.E. and S.S.W. *across* the great lode. Similarly the blende, west of the Swansea shaft, is sharply terminated. West of Hathorne's shaft, another column of chalybite extends for only a few feet in the direction of the strike; and it is succeeded on the east by a quartz filling, of which a great part consists, (as is well seen in the fifty fathom level) of parallel ribs of what miners term "cross-course spar." These plates, often only half an inch to an inch or two thick, are thoroughly crystalline, and contain frequent pseudomorphous impressions of octahedral fluor spar, whilst, strange to say, instead of being placed parallel to the walls of the great lode, they set across it in the same direction of N.N.E. to S.S.W., and thus remind the observer of the trans-

verse strings of cassiterite or tin in the elvan dyke at Wheal Jennings,* the old Parbola mine.

The completion of a good railway from Newquay to these mines has obviated one of the difficulties in mining the district, and the discovery of the blende in quantity has given a fillip which it is hoped may conduce to further successful exploration.

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* *Vide* SEYMOUR on "Wheal Jennings," *Tr. R.G.S.C.*, vol. ix. p. 185.

THE EVIDENCE OF GLACIAL ACTION IN CORNWALL AND DEVON.

By Nicholas Whitley, C.E.

In two former papers read before this Society I described what appeared to me to be conclusive evidence of the existence of glacial deposits and of ice action in the South-West of England.

So far back as 1854 I described in our *Transactions* (vol. viii. p. 236) the so-called "Raised Beaches" at the estuary of the Taw, and inferred that these ancient gravel beds were the remaining portions of northern drift which formerly extended much further seaward, and choked up the mouths of the rivers, and filled the bays around our coast-line. Again, in the *Transactions* of our Society for the year 1875 (vol. ix. p. 109), I described the geology of the shores of Penzance Bay, and came to the conclusion that the extensive bed of sand, pebbles, and boulders at Wheal Darlington Mine, inside the Eastern Green, corresponded in every respect with the "raised beaches" exposed in the cliff sections; and that these beds are stamped with all the geological elements which constitute the "drift" of the glacial age.

For a period of over twenty-five years I have examined and made sections of most of these patches of gravel over the whole of the coast-line of the South of England. To this end I have also explored the islands of Scilly and Lundy, the north coast of Cornwall and Devon, and the coast of South Wales, as far as Caldy Island. During the past summer I have been able to extend my researches to the estuary of the Tivy, on the west coast of Wales, and to the country around Cardigan.

I have thus been enabled to trace up these patches of drift gravel to where they are more fully developed and recognized as the true deposits of the glacial age, and I find throughout the whole series a uniformity of material, of geological position and structure; thus, if the links of this chain of evidence are without a flaw, then the geological age of these so-called "raised beaches" is established; and probably also that of the stream tin deposits of our valleys.

That these ancient gravel beds are not ordinary sea beaches raised by the elevatory movements of the land, appears to be conclusively shown by the fact that the materials of which they are composed have been washed down from the land, and not cast up by the sea. They are mostly found at the mouths of our rivers and shallow valleys, as at Par, where the drift bed lies on both sides of the harbour. This drift also covers the whole of the lowland of Spit Point, and may be traced in the cliff section for a considerable distance westward, rising from the level of high-water to twenty feet above it, conforming itself to the

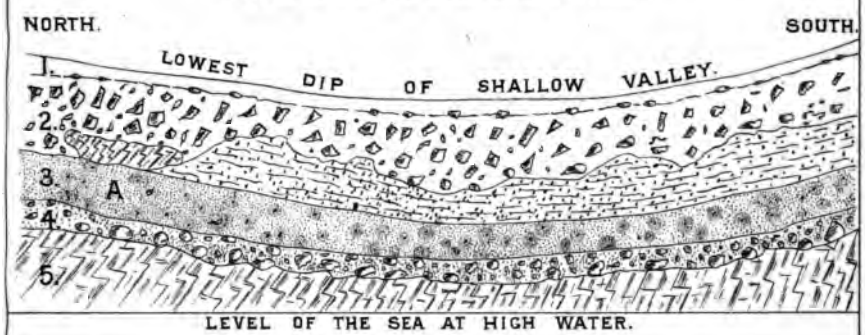
natural slope of the ground. The boulders and pebbles are composed of granite, elvan, quartz, and altered slate, the parent rocks of which are all found along the inland course of the valley, and at Par village the boulders are found at the base of the hill on the west side of the valley.

Again, where open valley depressions run down to the coast line (as at Godrevy, in Hayle Bay), the gravel bed is thickest at the lowest dip of the ground, and rises like a mantle over the slopes of the valley on both sides; and it becomes obvious that the gravel bed is not a sea beach, but a valley deposit, cut back and exposed by the action of the sea. A similar section, where the gravel conforms to the ancient slope of the land, may be seen at Fistral Bay, west of Newquay.

Again, these gravel beds are more fully developed where a low isthmus connects a jutting peninsula with the main land. This may be seen at both sides of Cape Cornwall: at the neck, between St. Ives and the island; on the low ground between the Towan Head and Newquay; and more especially between the high ground of Trevose Head and Harlyn House. In such situations the drift partakes more of the character of a marine deposit, foreign rocks are abundant, and flint pebbles, unbroken and water-worn, are found in the gravel; but at the base of the soil the drifted flints are crushed into flakes. These gravel beds must, however, have formerly extended far beyond the present coast line, as we find rocks of a distant origin and chalk flints, in the trail of drift

LONGITUDINAL SECTION OF THE "RAISED BEACH" AT GODREVY, SAINT IVES BAY.

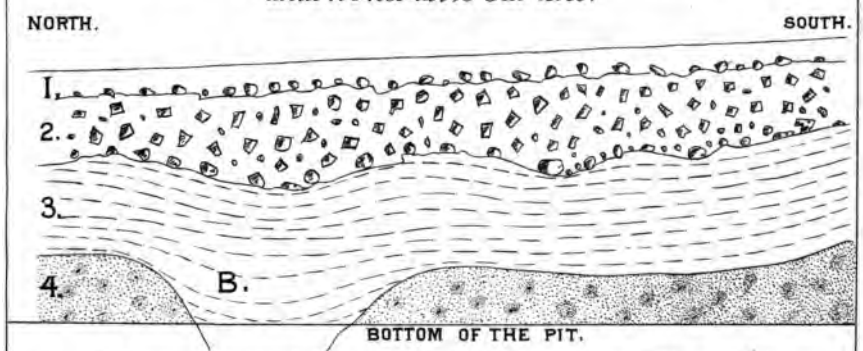
Depth of Section from 8 to 12 feet.



1. *Soil, passing into subsoil.*
2. *"Head" of angular stones and loam, mostly on edge. Large piece of dislodged slate at* A.
3. *Red and White fine silicious sand.*
4. *Boulders, pebbles, and sand. (Raised Beach.)*
5. *Killas (slate).*

LONGITUDINAL SECTION OF A SAND PIT ABOUT A QUARTER OF A MILE NORTH OF ST ERTH VICARAGE HOUSE.

about 100 feet above Sea level.



1. *Soil passing into clayey subsoil with stones and pebbles at base.*
2. *"Head" of angular stones and loam, with waterworn stones and a few chalk flints at base — 3 to 4 feet.*
3. *Pure tough Boulder Clay, with marine shells at* B. *5 to 10 feet.*
4. *White and Red beds of fine silicious sand, the base not seen.*

which swept over the Scilly Isles, and also on the detached rocks and islets of St. Clements, Lundy, and Caldy. At the latter spot I found patches of drift full two hundred feet above the sea level.

In the *Transactions* (vol. ix. p. 132) of this Society for the year 1860 there is on this subject a most valuable paper by the late Miss Elizabeth Carne, in which that lady produced a large amount of evidence to show that the cliff boulders of the Land's End district differed in many respects from the present sea beaches, and expressed the opinion that they are in our cliffs that which stream tin is in our valleys; the earliest record of the action of water (liquid or frozen) upon existing rocks. Thus the evidence against these ancient gravels being "raised beaches" has gathered accumulated weight by later investigations.

I now turn to consider the positive evidence that the gravel beds on our coast line, and elsewhere, are the westward extension of the glacial drift so fully developed and recognized on the western coast of Wales.

On both shores of the estuary of the river Tivy, below Cardigan, the boulder clay is strongly developed; and on the east cliff, near the Bar, the boulders protrude from the clay, and are scattered abundantly over the sea-bed below.

In a clay-pit at a brickyard north of Cardigan town a section of the boulder clay, about fifty feet high, is exposed, showing irregular patches of gravel and sand. The boulders are composed of grey and

purple grits, six or seven varieties of fine-grained granite, often red, and passing into syenite, much trap, and a few pebbles of chert and flint. Some of the boulders are polished, scratched, and scarred; one such, of granite, was 3 feet 6 inches in diameter. Casting my eye over the face of the country, I observed a group of conical hills, of a very symmetrical form, about three miles N.E. from Cardigan, described on the Ordnance Map as the Warren. Passing over a large extension of boulder clay on Cardigan common, I explored these hills, and found them to be composed of very fine siliceous sand, the grains of which, under the microscope, were seen to be of semi-rounded transparent quartz, with about one per cent. of black grains of schorl, or hornblende. This sand was as fine-grained as that of an hour-glass, and in such immense masses that some of the hillocks are half a mile in diameter. On the outskirts of these mounds was a large gravel-pit of sand and boulders, showing a rough stratification.

Above the village of St. Dogmels a deep V-shaped excavation in the hill exhibited a good transverse section of the upturned hard grits and shales, the broken tops of which were crushed and curved downwards to the main valley.

The position of many of the boulders and angular stones, both in the clay, was that which is peculiar to the boulder drift. Professor Ramsay says: "Most of these marine boulder-drifts are rudely stratified when viewed on a large scale, and, as already stated, often interbedded with sand and rounded gravel;

but it is remarkable that in most of the clays that form the larger part of the formation the stones and boulders that stud the mass are scattered confusedly, and frequently stand on end, like the stones in the moraine-till of Scotland and the North of England."*

In all these respects the erratic gravel beds of the West of England correspond with the glacial drifts of Cardigan. The red granite and blue grit boulders of Bideford Bay are even more numerous than those at the mouth of the Tivy, and may be seen pitched upright in the clay at low-water, or uprooted by the surf, and thrown up to form the well-known massive Northam pebble-ridge.

The fine siliceous sand of Cardigan, when associated with and overlying the boulders or gravel, is a marked feature of this glacial drift; and similar sand overlies, and is largely developed in, all our "raised beaches," and over and between the cliff boulders of the Land's-End district. This fine white and red sand alternates with the clay beds of St. Agnes Beacon, and is found in large patches around the Hayle estuary, and largely used as moulding sand at Hayle foundry. From various places I have collected fifteen samples of this sand, which I now exhibit. The uniformity of material and of size is strongly marked in all the samples; nor less strongly is the *contrast* marked between this siliceous sand of the drift and the shell sand of our northern sea beaches.

Hitherto it has been considered that no true

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* *The Physical Geology of Great Britain*, third edition, p. 155.

boulder clay has been found in Devon or in Cornwall. I am however enabled to produce evidence, which appears to be conclusive, that it exists far to the west in our county. About a quarter of a mile north of the vicarage-house of St. Erth there is, in a basin-shaped depression, a large open sand-pit, which has been extensively worked for moulding purposes. Inspecting this pit during the past summer, I found a large bed of pure, tough, grey clay exposed, from 5 to 10 feet deep. It is interstratified between beds of fine siliceous sand, and both the clay and the sand are similar to those of the Cardigan drift. The workmen informed me that clusters of broken shells were often found in the clay, and a short search produced the marine shells which I now exhibit, with a portion of the clay in which they were deposited. I also give a section of the beds on the east side of the pit. There is also the corroborative evidence of these beds being overlaid by the "head" of angular stones and loam, in which the stones are often, as in the true drift, pitched upright, and this again covered by the usual crushed fragments found in the subsoil, above which is a deep loamy soil, the warp of the drift. A similar "head" of angular stones and loam covers the "raised beach" at St. Ives, and in it are found large masses of greenstone, which only ice-action could have brought from the high land above.

Additional evidence of ice-action may be observed on the face of the land along the coast from St. Ives to St. Just. Here large blocks of granite have been

severed from their native bed and carried down the slope of the hills, overriding the angular "head," and lodged over the beds of killas below the edge of the granite boss, even to the coast; and as the coast line is worn back by the sea, these blocks topple over and fall on the beach. It is therefore highly probable that the general outline of hill and dale had received its present form before the close of the glacial age.

I have not, however, detected any scratched or striated markings on these granite blocks. We must take into consideration that their upper surface has been exposed to the waste of atmospheric agencies for a period of great duration, the measure of which is indicated by the hard schorlaceous bosses which protrude from their surface, often to the extent of from two to three inches—sometimes termed pig's-eyes—and their rounded exposed faces, compared with their flat base, further indicate such an amount of waste as would obliterate all such markings; so that it is only on the flat base of such rocks that we might now reasonably expect to find glacial groovings.

Further, it should not be overlooked that there are patches of gravel, very similar to that of the "raised beaches," on the high land near our coast line, which appear to indicate a great submergence of the land after it had assumed its present outline of coast and surface; such as the orphan beds of sand and clay of St. Agnes Beacon, which are very like the drift of Cardigan. The large patch of gravel on Crousa Downs, near St. Keverne, 360 feet above the sea, may be traced by its trail down the slope of the hill

to the gravel forming the St. Keverne lowlands and the "raised beaches" near. But the most instructive example of such beds of drift is that which I discovered at Plymouth, and described in the *Western Daily Mercury*, in July, 1875. In excavating for the foundations of the hotel on the top of the Hoe, about 120 feet above the level of the sea, a bed of boulders and pebbles, in a matrix of clay, with white and red sand, was exposed. The boulders were of granitoid rock, indurated slate and quartz, and a few chalk pebbles. I traced the trail of this drift down the face of the Hoe to a fissure in an inland cliff, which it filled to a depth of 25 feet; and from thence down the slope of the hill to the remaining remnants of the "raised beach," a few feet above high-water mark. This gravel bed was described by Mr. Hennah in 1817, and by Mr. Moore in 1841. The position of this gravel is shown by the accompanying section, from which we are led to infer that the inland patches of gravel are contemporaneous with the so-called "raised beaches," and also with the gravel which fills the inland fissures of the rocks, and which also probably supplied the materials which constitute the lowest beds of the Devonshire bone caves.

I have in this paper given only the main outlines of this subject, in order that I might keep within the limits of a single yet comprehensive inquiry. The examination of the details opens up a subject of great interest, and demands further research, and will, I hope, receive from other members of our Society that consideration which it invites.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—When I was invited to undertake the honourable office, the duties of which I am now about to attempt for the first time to discharge, I felt very considerable reluctance in accepting the position. Indeed, I may say, that but for the gentle insistance of your Council, represented by the letters of the Secretary, I should resolutely have declined the post for which you have selected me. This, I can assure you, was not from any want of interest in the Society, or want of respect, and I may almost say affection, for its past history. My mind goes back a great many years—to the days, very long since now, when I was in the habit sometimes of attending the annual meetings. I am afraid it is now more than thirty years since I have been at an annual meeting, the season in which the meetings were held preventing my attending in the interval. But in those days, thirty or more years ago, when a small society used to meet in North Parade, there were men present whose memory cannot be recalled without respect and regard. You had then filling your chair a gentleman who was able to add to a most honourable and distinguished position in the House of Commons a real reputation as a man of science in the first rank; I mean Sir Charles Lemon. You had an old and respected inhabitant in this town who has now passed from us—Mr. Henwood—conveying lustre upon his native county by the perseverance and originality of his investigations. And you had also among the officers two names I would venture to recall, the names of the secretaries of the time to which I refer—one a man of great accomplishments and worth, endeared in private life, who passed

Mr. John H. James, of Truro, has kindly examined the shells found in the clay for me, and had them verified and described by Mr. G. B. Sowerby, junr., as follows:

THE FOSSIL SHELLS FROM THE CLAY BED.

1. *Nassa reticulata.* Living in abundance on British shores; also found in Glacial Deposits and in the Crag.

2. *Murex erinaceus.* Common on the shores of Great Britain, and also in the Mediterranean. It is also common in the Crag, and is found, I believe, in Glacial Deposits.

3. *Ostrea edulis.* (The Common Oyster.) Also found in Drift and Glacial Deposits.

4. *Natica monilifera.* Common, and general on the shores of Great Britain.

5. *Purpura lapillus.* Common, and general on the shores of Great Britain, Drift and Glacial Deposits, and Crag. Specimen peculiarly inflated.

6. *Trochus.* Not belonging to any recent British species.

7. *Turritella.* Not belonging to any recent British species.

8. The only known recent shell resembling this is *Nassa mutabilis,* which is not half the size, and is not found on the shores of Great Britain, but only in the Mediterranean.

9. Does not belong to any living British species. It looks like *Fusus* (*Euthria*) *lactea,* which is found on the shores of New Zealand. It is certainly not a Boreal species.

10. *Trochita.* Not belonging to any living British species; but I believe it is the same as one found in the Eocene at Barton.

G. B. SOWERBY, JUNR.

45, GREAT RUSSELL STREET,
LONDON, *Feb. 20th,* 1882.

Thus the shells are undoubtedly marine, and some of them show indications of glacial belongings. They are of various sizes; the oyster shells in particular, varying from that of a full-size oyster to the size of a shilling.

ON A NEW METHOD OF VENTILATING 'ENDS' BY COMPRESSED AIR.

By W. Teague, junr., Assoc. Inst. C.E.

Though the introduction of machine drills has been of incalculable benefit to mining in enabling levels to be driven at a greatly increased speed, it cannot be denied that the new method of working is accompanied by one evil. I allude to the increased amount of noxious fumes produced in a given space of time. Where hand labour is used, the quantity of powder or dynamite consumed in a shift may almost be reckoned by ounces, whereas in the case of driving an 'end' by boring machinery, many pounds have to be exploded in the course of a few hours.

The modern system of driving consists in boring eighteen or twenty holes three feet deep in the working face. The four centre holes, a foot apart on starting, converge, and are only six or eight inches apart at the bottom. These are charged and fired together, and blow out a large pyramidal centre or core. The remaining holes are fired in successive volleys of four or five at a time, and the drivage is thus finally advanced about three feet. In order to secure rapid progress it is necessary to reduce the intervals between the volleys as much as possible.

The consequence of this method is, that the men have to breathe a highly-polluted atmosphere in

going to and from the face, and while preparing to fire the successive volleys. It is true that the air escaping from the supply-pipe does much to improve the ventilation (indeed without it there would be no possibility of working); but nevertheless, unless a long time is allowed to elapse after each volley, the deleterious gases do not become sufficiently diluted to render the atmosphere thoroughly healthy. I may here express my conviction that, in spite of the assertions of the makers and sellers of explosives, noxious fumes are created by all of them.

It occurred to me some time ago that, instead of employing the compressed air to dilute the injurious gases, it would be better to use it in another way while blasting is going on. The object of my invention, which I have patented, is to create an exhaust at the face, and cause the noxious products of the explosion to be sucked into a pipe and carried out of the level to a place where they can be dissipated without injury to the workmen.

My mode of effecting this object is as follows:

Let A be the air-main conveying compressed air to the boring machine through the flexible hose B. A one-inch pipe C is connected with the main by a T-socket, and provided with four nozzles or jets, only partly shown in the figure. These jets are arranged so as to deliver streams of air into a piece of 4-inch pipe D, about 6 feet long, which is enclosed in a 6-inch or 8-inch ventilating pipe E; this is carried to the mouth of the level, or further if necessary.

After all the holes have been bored in the face of

away prematurely, to the grief of his friends, who had a real zeal for science, and who pursued it from a real love of it—Mr. Samuel Pidwell. Then there is the name of one recently gone, to whom I am bound to refer, though I confess with some little effort—my most dear and honoured friend, whose kindness to and sympathy with myself were more than that of a father—to whom I was very much indebted in earlier years, and whose name amongst you and myself will be held precious. I need not say I am referring to Dr. Willan. I felt great diffidence in accepting this office. I am not a geologist. I have, indeed, paid but comparatively small attention—much less than I ought—to the sciences. As you are probably aware, my pursuits have been more in the paths of literature, and perhaps I may add, of art, with that of special attention to social and political subjects which one is bound to give in the position I occupy. Therefore physical science has not by any means had a foremost place in my education, and I am sure I do not disappoint you in making this confession. I regard your electing me as president—I trust not incorrectly—as a testimony of friendly sympathy to one whose fondest recollections are associated with this town, and who, wherever he may live, and however long he may live, will always turn to it with affection and pleasure.

You are all aware this is said to be a pre-eminently scientific age. The triumphs of science form one of the commonplaces of our time. The duties we owe to scientific men, and scientific progress, are spoken of in every land and in every tongue. I would, in the first place, you should consider with me a thought which has often occurred to me, What is that great debt we in the present day owe to science? I am inclined to think there are two things brought forward as special discoveries which command our respect and gratitude. One is the introduction of the electric telegraph, the pursuit of electricity, so as to render it the servant we have been able to make it—and which, after all, is but the beginning of the use we are going to make of that extraordinary power—and the other the harnessing of the power of steam so as to make it our agent in every department of life. The electric telegraph in especial, seems to make us masters of the world. One or two

people, sitting perhaps in an obscure cabinet in London, a director of Mr. Reuter's company, or the editor of the *Times*, to whom come almost every hour—almost every minute—messages from all parts of the globe, thus hearing the tick-tack of the clock of the world, impress us with the great idea of what has been done by science in that direction. As for steam, you all know what has been said, and rightly said, in praise of the advantages we can derive from the use of that power. All our wants are satisfied by it, and things are brought to us much more expeditiously and with less toil. Our debt here is manifest, but still I am bound to say that, in my opinion, we may overrate this debt. After all, the conveyance of news from any part of the world is in itself insignificant if the news itself is not of importance, and as to this diminution of the toil of man it depends entirely on the use we make of it, how far it does or does not confer a benefit on mankind. The toil of life is said to be reduced, but is it a fact that the labour which is necessary to the subsistence of the multitude has been diminished? Is it a fact that the ragged edge of pauperism and crime which surrounds our borders, constituting the utmost verge of society, has disappeared? One of two advantages we may derive from these discoveries—either make life less toilsome for the same numbers, or increase numbers with the same toil of life. I am afraid most of the discoveries have not diminished the toils of life. Therefore I cannot feel precisely the same interest and gratitude which I hear with a constantly repeated echo. I am indeed more disposed to reverence science for its educational and economic advantages, for the effects it may have had on the mind of man rather than for the material comfort of man. And it is because I believe in geology, and its kindred science astronomy, as two powerful helps to the education of the mind, I for one am ready to pay my humble tribute of respect to those who prosecute them and convey to us their lessons. Just think for a moment how geology tends to elevate the mind of man, first in consideration of man and time. Our natural impulse is to live entirely in the moment in which we find ourselves—to consider life bounded by our own little experience of the few years we have passed. The study of geology in the

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Robert Tweedy, Truro.
Alfred Tylor, F.G.S., Carshalton, Surrey.
Arthur Pendarves Vivian, M.P., F.G.S., Glendorgal, Newquay, and Glan Afon, Taibach, South Wales.
The Rev. Sir Vyell Vyvyan, Bart., Trelowarren, Helston.
Nicholas J. West, Hayle.
John Westlake, Q.C., River House, 3, Chelsea Embankment, London, S.W.
Mrs. Williams, Carhayes Castle, St. Austell.
George Williams, Scorrier.

ASSOCIATES.

Arundel Anthony, Lelant.
James Bennetts, North Levant Mine, St. Just.
J. T. Blight, F.S.A., Penzance.
J. H. Collins, F.G.S., Rio Tinto Mines, Huelva, Spain.
Wm. Eddy, Boscaswell, St. Just.
James Evans, Nance, Illogan.
John Giles, East Looe.
William Gregor, Swansea.
R. T. Hall, formerly of Cape Copper Mines, Africa.
William Hollow (formerly Manager of the Providence Mines), Leyton, Essex.
Benedict Kitto, F.G.S., The Assay Office, George Yard, 36, Upper Thames Street, London, E.C.
S. Michell, Swansea.
John Nancarrow, Camborne.
Francis Oats, F.G.S., Diamond Fields, Kimberley, S. Africa.
John Phillips, Australia.
T. B. Provis, Assoc. Inst. C.E., Camborne.
John Rowe, The Terrace, St. Just.
Stephen Thomas.

Names of Associates whose exact Addresses are unknown.

Hall, R. T. | Phillips, John.
Thomas, Stephen.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—When I was invited to undertake the honourable office, the duties of which I am now about to attempt for the first time to discharge, I felt very considerable reluctance in accepting the position. Indeed, I may say, that but for the gentle insistance of your Council, represented by the letters of the Secretary, I should resolutely have declined the post for which you have selected me. This, I can assure you, was not from any want of interest in the Society, or want of respect, and I may almost say affection, for its past history. My mind goes back a great many years—to the days, very long since now, when I was in the habit sometimes of attending the annual meetings. I am afraid it is now more than thirty years since I have been at an annual meeting, the season in which the meetings were held preventing my attending in the interval. But in those days, thirty or more years ago, when a small society used to meet in North Parade, there were men present whose memory cannot be recalled without respect and regard. You had then filling your chair a gentleman who was able to add to a most honourable and distinguished position in the House of Commons a real reputation as a man of science in the first rank; I mean Sir Charles Lemon. You had an old and respected inhabitant in this town who has now passed from us—Mr. Henwood—conveying lustre upon his native county by the perseverance and originality of his investigations. And you had also among the officers two names I would venture to recall, the names of the secretaries of the time to which I refer—one a man of great accomplishments and worth, endeared in private life, who passed

away prematurely, to the grief of his friends, who had a real zeal for science, and who pursued it from a real love of it—Mr. Samuel Pidwell. Then there is the name of one recently gone, to whom I am bound to refer, though I confess with some little effort—my most dear and honoured friend, whose kindness to and sympathy with myself were more than that of a father—to whom I was very much indebted in earlier years, and whose name amongst you and myself will be held precious. I need not say I am referring to Dr. Willan. I felt great diffidence in accepting this office. I am not a geologist. I have, indeed, paid but comparatively small attention—much less than I ought—to the sciences. As you are probably aware, my pursuits have been more in the paths of literature, and perhaps I may add, of art, with that of special attention to social and political subjects which one is bound to give in the position I occupy. Therefore physical science has not by any means had a foremost place in my education, and I am sure I do not disappoint you in making this confession. I regard your electing me as president—I trust not incorrectly—as a testimony of friendly sympathy to one whose fondest recollections are associated with this town, and who, wherever he may live, and however long he may live, will always turn to it with affection and pleasure.

You are all aware this is said to be a pre-eminently scientific age. The triumphs of science form one of the commonplaces of our time. The duties we owe to scientific men, and scientific progress, are spoken of in every land and in every tongue. I would, in the first place, you should consider with me a thought which has often occurred to me, What is that great debt we in the present day owe to science? I am inclined to think there are two things brought forward as special discoveries which command our respect and gratitude. One is the introduction of the electric telegraph, the pursuit of electricity, so as to render it the servant we have been able to make it—and which, after all, is but the beginning of the use we are going to make of that extraordinary power—and the other the harnessing of the power of steam so as to make it our agent in every department of life. The electric telegraph in especial, seems to make us masters of the world. One or two

people, sitting perhaps in an obscure cabinet in London, a director of Mr. Reuter's company, or the editor of the *Times*, to whom come almost every hour—almost every minute—messages from all parts of the globe, thus hearing the tick-tack of the clock of the world, impress us with the great idea of what has been done by science in that direction. As for steam, you all know what has been said, and rightly said, in praise of the advantages we can derive from the use of that power. All our wants are satisfied by it, and things are brought to us much more expeditiously and with less toil. Our debt here is manifest, but still I am bound to say that, in my opinion, we may overrate this debt. After all, the conveyance of news from any part of the world is in itself insignificant if the news itself is not of importance, and as to this diminution of the toil of man it depends entirely on the use we make of it, how far it does or does not confer a benefit on mankind. The toil of life is said to be reduced, but is it a fact that the labour which is necessary to the subsistence of the multitude has been diminished? Is it a fact that the ragged edge of pauperism and crime which surrounds our borders, constituting the utmost verge of society, has disappeared? One of two advantages we may derive from these discoveries—either make life less toilsome for the same numbers, or increase numbers with the same toil of life. I am afraid most of the discoveries have not diminished the toils of life. Therefore I cannot feel precisely the same interest and gratitude which I hear with a constantly repeated echo. I am indeed more disposed to reverence science for its educational and economic advantages, for the effects it may have had on the mind of man rather than for the material comfort of man. And it is because I believe in geology, and its kindred science astronomy, as two powerful helps to the education of the mind, I for one am ready to pay my humble tribute of respect to those who prosecute them and convey to us their lessons. Just think for a moment how geology tends to elevate the mind of man, first in consideration of man and time. Our natural impulse is to live entirely in the moment in which we find ourselves—to consider life bounded by our own little experience of the few years we have passed. The study of geology in the

most elementary manner carries us back year by year—first thousands, then tens of thousands, then, in the latest pursuit, may approach to millions of years. More than that, as we study geology, and follow with our minds all the workings of the past, we discover we are in the middle of a process which is not arrested, and which will go on in the future as before, and the mind can travel forward in the future as it has gone back in the past, and realizing the conditions of the action of the earth, we are able to comprehend what may be the physical condition of the future, as well as we have been able to comprehend what has been the physical condition of the past. You know the most elementary phase in which geology consists, is the construction of strata by the slow detrition of primary rock, and the maintenance and accumulation of the deltas of rivers tending to form new continents, or, as our poet laureate has expressed it—

> "Draw down Æonian hills and sow
> The dust of continents to be."

But this is a comparatively limited scheme of action. As we pursue the study of geology, we find a longer and much more prolonged process of earthy substances rising. We find continents slowly lifted in some direction, and slowly formed, not from this process of detrition, but from the action of some subterranean forces we have not been able to measure. This action, the formation of the earliest rocks, as we go back step by step through the different periods, is a process employing enormous time, and the mind of man is entirely baffled in the attempt to conceive the length of time during which the world has existed as a habitable world; and when we go still farther back and call in aid astronomical thought and investigation and try to conceive more of the creation of the world, we are carried back into what is said to be hundreds of millions of years, unto the appearance of the world as a mere spot moving in space. It is in this way the power of the mind is developed into a conception of time. It is equally wonderful to conceive of man in relation to space. We ourselves know the little area in which we live. We associate it with other parts of the globe. We discover elsewhere similar phenomena to

those under our feet and about us. Man, rising above the particular position he occupies, is able to conceive of that position as a part of the whole world—the globe we inhabit takes its place in the universe or cosmos—and I don't know anything more elevating to the spirit than the power which thus arises from the study of geology, of being able to place yourself at the centre of the physical universe you will have opened, and thus taking this earth of ours and conceiving its construction in respect of the rest of the world. Now, there is just one other thought of the educational influence of geology to which I will refer, and that is the effect of geology in bringing man into a conception of the relation between himself and life—man and life as well as man and time, and man and space. You know well how geological research has affected our conceptions of the history of the human race, how it has carried us back step by step, every succeeding investigator forcing back the primeval man, until we are now able to trace our own race through every stage of creation up to the position which it now occupies. But it does more than that. We find man following other forms of life—possibly derived from and certainly connected with them,—we find these forms of life following others and again others, and we discern in each successive stage of life a manifest growth, a developing progress from type to type, until the very first element of life is scarcely distinguishable from inanimate matter. We arise by a very slow progress—slow, but sure—to the position we now occupy, and all these ideas of the relation of man with space, with time, and with life, are derived by the student of geology from the few materials he has had at his immediate command. We pace a few feet; we live a few years, and we apply these measuring rods of our small experience to all space and all time. I think we, to whom geology is but a part of a liberal education, who cannot profess the proud boast of being geologists ourselves, must know how much our common life is affected by the study undertaken by others for us, how much our ideas have been enlarged by their investigations, how much we are indebted to them for the results of their investigations.

Let me add one more thought—a practical thought, which I,

in my own profession, as I may say, have carried away from the study of geology. Almost all these great processes of action to which I have referred have been gradual. The older geologists were fond of theories of violence—heat, water, fire and water in some great convulsion, some great cataclysm, affecting the face of the world and making it what it is. No doubt there have been periods of violence, but the later investigations of geologists have led us to believe that what has been done has been done by gentleness, by slow continuous action, and not by violence. Patience and perseverance are the particular mottoes we may deduce from the geological record. This is the thought I submit to you last.

Changes are frequently proposed to us for our investigation, and as often are we met with this remark, "It is idle to talk of this or that change, it is idle to hope for this or that thing, it is Utopian, and these are dreams which, as long as human nature is what it is, will never be attained." Now, I think geologists may bid us take comfort, may bid us see whether or not human nature has advanced considerably, whether in the future we should look forward to less changes than in the past, whether we should reject as impossible any ideal from seeing what man was in the past, and what man is. Therefore, instead of losing heart, instead of giving up hope, instead of shrinking because your own action appears to avail nothing, instead of ceasing to work because the future is so far distant, I would say, Listen to the geologist, and the burden is this: Work on for the future, however distant it may be; for by slow attrition, by constant action, changes which now appear Utopian may become real, and may become some of the triumphs of humanity.

REPORT OF THE COUNCIL.

In presenting their Sixty-ninth Annual Report, it once more becomes the pleasing duty of the Council to congratulate the Members of the Society upon its present satisfactory condition and continued usefulness.

The most notable event which has occurred in the history of the Society for some time past, is the compilation and completion of the Catalogue of the Library, a work which has been carried out with zeal and ability by your Assistant Curator and Librarian, Mr. W. Ambrose Taylor.

The thanks of the Society are also due to the Rev. Prebendary Hedgeland, Mr. Warington W. Smyth, and Dr. C. Le Neve Foster, for their assistance during the passage of the work through the press.

Copies of the Catalogue are now ready for distribution.

A large number of volumes have been bound during the year, and the newly-arranged and well-filled cases suggest the desirability of additional shelf room as soon as may be convenient.

The donations to your Museum, though scarcely as numerous as on some former occasions, are many of them of interest and value. They will be enumerated in the report of your Curator. The Library Catalogue being finished, Mr. Taylor will now be able to devote more time to the mineralogical and other collections.

Over 700 visitors have entered their names in your Visitors' Book during the year.

The Science Classes, conducted by Messrs. Barnett and Corin, have steadily progressed, their utility is more fully recognized, and they have been re-arranged upon a firmer footing than heretofore.

It is proposed to distribute the prizes to the successful students this evening in St. John's Hall.

The Scientific and Industrial Exhibition lately held in St. John's Hall resulted in the extinction of the debt with which the Classes had been previously burthened.

Since we last met, Mr. Richard Foster Bolitho, one of our oldest members and most valued friends, has been removed from the Society by death; and we have also lost one of our most able Associates, Captain John Maynard, of East Pool Mine, Camborne. The death of a former Secretary, who held office in the year 1841 and three following years, occurred on 22nd May last, and all who knew him will regret the decease of Dr. Willan.

In conclusion the Council desire to recommend the election of Mr. F. M. Harvey as an ordinary member of this Society.

GEORGE BOWN MILLETT,
Honorary Secretary.

PENZANCE, *29th Dec.*, 1882.

LIBRARIAN'S REPORT.

THE following works have been added to the Library:

I. TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies, Editors, and other Donors, or purchased.

Anglesey, Brecon, &c. Dr. C. Le Neve Foster's Report upon the Inspection of Metalliferous Mines in the Counties of Anglesey, Brecon, Cardigan, Carnarvon, Denbigh, Flint, Merioneth, Montgomery, Radnor, and Shropshire, and in the Isle of Man, for the year 1881. [To 31st Dec.] Folio. [London] 1882. [Presented by Dr. Le Neve Foster.]

Boston. American Academy of Arts and Sciences. Memoirs: Centennial Volume—vol. xi. part 1. 4to. Cambridge (Mass.), 1882.

Bristol. Bristol Naturalists' Society. Proceedings: New Series, Vol. iii., part 3. 8vo. Bristol, 1882.

Brussels. Société Royale Malacologique de Belgique. Procès-verbaux des séances: Tome xi., année 1882. 8vo. Bruxelles, [1882].

Cambridge. University College. Twenty-eighth Report of the Library Syndicate to the Senate. Folio. n.p., 1882.

Cambridge (Mass.) Museum of Comparative Zoology, Harvard College. Memoirs.

——. Auriferous Gravels of the Sierra Nevada of California. Part 2. By J. D. Whitney. 4to. Cambridge, 1880.

Cambridge (Mass.) Annual Reports . . . of the Museum of Comparative Zoology at Harvard College, 1866–1881, inclusive. 8vo. Cambridge, 1867–81.

[Presented by Professor J. D. Whitney.]

Canada. Geological and Natural History Survey of Canada: Report of Progress for the year 1879–80, accompanied by Maps. 8vo. Montreal, 1881.

Cornwall, Devon, &c. Mr. R. J. Frecheville's Report on the Inspection of Metalliferous Mines in Cornwall, Devonshire, Dorsetshire, and part of Somersetshire, for the year ended 31st December, 1881. Folio. [London, 1882.]

Dorpat. Dorpater Naturforscher-Gesellschaft. Archiv für die Naturkunde Liv-, Esth- und Kurlands:

——. II. Serie.—Biologische Naturkunde. Band ix., heft 3, 4. 8vo. Dorpat, 1881.

——. Sitzungsberichte. Band VI., heft 1 [1881]. 8vo. Dorpat, 1882.

Dublin. Royal Dublin Society.

Scientific Transactions: parts 13, 14, vol. i., series ii. 4to. Dublin, 1880–81.

——. Scientific Proceedings: part 7, vol. ii., new series; parts 1–4, vol. iii., new series. 8vo. Dublin, 1880–81.

Edinburgh. Royal Society of Edinburgh. Proceedings: Vol. xi., Session, 1880–81. 8vo. Edinburgh.

Falmouth. Royal Cornwall Polytechnic Society. Forty-ninth Annual Report, 1881. 8vo. Truro, Falmouth, N.D.

India. Geological Survey of India.

——. Memoirs: Vol. xviii., parts 1–3. 8vo. Calcutta, 1881.

——. „ „ xix., part 1. 8vo. Calcutta, 1882.

——. Palæontologia Indica:

The Flora of the Damuda and Panchet Divisions (conclusion of part 2). By Ottokar Feistmantel. Productus-Limestone Fossils—iii.; Pelecypoda. By W. Waagen.

The Fossil Echinoidea from the Strata beneath the Trap (Cardita Beaumonti Beds). By P. M. Duncan, and W. P. Sladen. 4to. Calcutta, 1881–82.

The Fossil Echinoidea from the Ranikot Series of Nummulitic Strata in Western Sind. By P. M. Duncan, and W. P. Sladen. 4to. Calcutta, 1882.

Siwalik Rhinocerotidæ. Supplement to Siwalik and Narbada Proboscidia. Siwalik and Narbada Equidæ. By R. Lydekker. 4to. Calcutta, 1881–82.

——. Records: Vol. xiv., parts 2–4. 8vo. Calcutta, 1881.

——. „ „ xv., „ 1–3. „ „ 1882.

——. A Manual of the Geology of India. Part 3—Economic Geology. By V. Ball. 8vo. Calcutta, 1881.

Leicester Literary and Philosophical Society. Report of the Council, June 26th, 1882; and the Transactions of the Society for the Session 1881–82. 8vo. Leicester, 1882.

——. Transactions: Part 8—June, 1865 to June, 1870, five sessions. 8vo. Leicester, 1882.

Liége. Société Géologique de Belgique. Annales: Tome vii., 1879–80; viii., 1880–81. 8vo. Liége, 1879–82.

London. British Association for the Advancement of Science. York Meeting, 1881. Report. 8vo. London, 1882.

London, Edinburgh, and Dublin Philosophical Magazine:

Series V., vol. xii., No. 77.
„ „ xiii., Nos. 78–84.
„ „ xiv., Nos. 85–90.
8vo. London, 1881–82. *Purchased.*

London. Geologists' Association. Proceedings. Nos. 3–5 of vol. vii. 8vo. London—Lewes, 1881–82.

——. Geological Society. Abstracts of Proceedings. Lists of Officers and Fellows, November 1st, 1881, and November 1st, 1882. Quarterly Journal: Vol. xxxvii., part 4. Vol. xxxviii. 8vo. London, 1881–82.

London. Palæontographical Society. Publications: Vol. xxxvi., 1882. 4to. London, 1882. *Purchased.*

——. Royal Society. Proceedings:
Nos. 216–219, vol. xxxiii.
Nos. 220, 221, vol. xxxiv. 8vo. London, 1881–82.

——. The Geological Record for 1878, with Supplements for 1874–77. Edited by W. Whitaker, and W. H. Dalton. 8vo. London, 1882. *Purchased.*

Manchester. Manchester Geological Society. Transactions:
Vol. xvi., parts 9–18.
Vol. xvii., parts 1, 2. 8vo. Salford, 1881–82.

Newcastle-upon-Tyne Chemical Society. Transactions: Parts 5–11 of vol. v. 8vo. n.p., 1881–82.

——. North of England Institute of Mining and Mechanical Engineers. General Index to vols. i.–xxv., 1852–1876 of the Transactions of the Society. 8vo. Newcastle-upon-Tyne, 1877.

——. University of Durham College of Medicine. Prospectus for Sessions 1882–83. 8vo. Newcastle-upon-Tyne, 1882.

New Haven. Connecticut Academy of Arts and Sciences. Transactions: Vol. iv. part 2; vol. v. part 2. 8vo. New Haven, 1882.

New Mexico. Historical Society of New Mexico. Inaugural Address delivered by the Hon. W. G. Ritch, at the Adobe Palace, Santa Fe, Feb. 21st, 1881. Second Edition. 12mo. Santa Fe, n.m., 1881.

New South Wales in 1881, being a Brief Statistical and Descriptive Account of the Colony up to the end of the year, extracted chiefly from Official Records. Published by Authority. Compiled and Edited by Thomas Richards, Government Printer, Registrar of Copyright, &c. Second issue. 8vo. Sydney, 1882.

New South Wales. Department of Mines. Annual Report for the years 1880 and 1881. Folio. Sydney, 1881–82.

New South Wales. Royal Society. Journal and Proceedings, vol. xv., 1881. 8vo. Sydney, 1882.

Norwich Geological Society. Proceedings: Vol. i. part 6, session 1880–81. 8vo. Norwich, 1882.

——. Address at the Anniversary Meeting, 8th November, 1881: On the Conservancy of Rivers, Prevention of Floods, Drainage, and Water Supply. By J. H. Blake, President. 8vo. Norwich, 1882.

Norwich. Norfolk and Norwich Naturalists' Society. Transactions: Vol. iii. part 3. 8vo. Norwich, 1882.

Oxford. Bodleian Library. Donations to the Bodleian Library during the year ending 8th November, 1881. 8vo. Oxford, 1881.

Paris. Annales des Mines:
Série vii., tome xx.
„ viii. „ i. 8vo. Paris, 1881–82.

Penzance. Natural History and Antiquarian Society. Report and Transactions, 1881–82. 8vo. Plymouth, 1882.

——. Royal Geological Society of Cornwall. Transactions: Vol. v. 8vo. Penzance—London, 1843.
[Presented by W. Bolitho, jun., Esq.]

——. Transactions: Vols. i. ii. iii. 8vo. London—Penzance, 1818–28. *Purchased.*

Philadelphia. American Philosophical Society. Proceedings: Vol. xix., No. 109. 8vo. Philadelphia, 1882.

Pisa. Atti della Società Toscana di Scienze Naturali.
Memorie: Vol. v., fasc. 1°. 8vo. Pisa, 1881.
Processi Verbali. 8vo. Pisa, 1881–82.

Plymouth Institution, and Devon and Cornwall Natural History Society. Report and Transactions: Vol. viii., part 1, 1881–82. 8vo. Plymouth, 1882.

Truro. Royal Institution of Cornwall. Journal: Parts 1, 2 of vol. vii. 8vo. Truro, 1881–82.

United States. Geology of Wisconsin. Survey of 1873–79, vol. iii. 8vo. [Madison.] 1880.

United States. Atlas of Maps to accompany the above. Folio. Milwaukee, 1879.

[Presented by the Governor and Chief Geologist.]

——. Abstract of a Report upon the Geology and Mining Industry of Leadville, Colorado. By S. F. Emmons, Geologist-in-charge, Rocky Mountain Division, U.S. Geological Survey. 8vo. Washington, 1882.

[Presented by the Author "at the request of R. Pearce."]

Victoria. Report of the Chief Inspector of Mines to the Honourable the Minister of Mines for the year 1881. Folio. Melbourne, 1882.

—— Reports of the Mining Surveyors and Registrars of Victoria for the Quarters ended 30th June, 30th September, and 31st December, 1881; 31st March, and 30th June, 1882. Folio. Melbourne, 1881–82.

—— Mineral Statistics of Victoria for the year 1881. Folio. Melbourne, 1882.

Vienna. K. K. Geologische Reichsanstalt, Verhandlungen:
Nos. 8–18 (1881). 8vo. Wien, 1881.
„ 1–11 (1882). 8vo. Wien, 1882.

——. Catalog der Ausstellungs-Gegenstande bei der Wiener Weltausstellung. 1873. 8vo. Wien, 1873.

——. Führer zu den Excursionen der Deutschen Geologischen Gesellschaft nach der Allgemeinen Versammlung in Wien 1877. Herausgegeben von der Geschäftsführern Fr. von Hauer und Dr. M. Neumayr. 8vo. Wien, 1877.

Washington. Smithsonian Institution. Annual Report of the Board of Regents for the year 1880. 8vo. Washington, 1881.

—— List of the Foreign Correspondents of the Smithsonian Institution, corrected to January, 1882. 8vo. Washington, 1882.

——. First Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1879–80. By J. W. Powell, Director. 8vo. Washington, 1881.

II. GEOLOGICAL AND MISCELLANEOUS PUBLICATIONS.

Presented by the Authors or purchased.

Boué, Ami. Autobiographie du Docteur Médécin Ami Boué . . . né à Hambourg le 16 mars 1794, et mort comme Autrichien à Vienne. Le seul survivant quoique l'ainé de trois frères et d'une soeur. 8vo. Vienne, Novembre, 1879.

Broch, O. J. Le Royaume de Norvége et le Peuple Norvégien, ses Rapports Sociaux, Hygiène, Moyens D'Existence, Sauvetage, Moyens de Communication et Economie. 8vo. Christiania, 1876.

Brogger, W. C. Om Trondhjems Stifts Geologi af Th. Kjerulf og Fossiler fra det Trondhjemske af W. C. Brogger. Mit et Oversigtskart af K. Hauan og Th. Kjerulf, samt Træsnit. 8vo. Christiania, 1875.

——. Om Trondhjemsfeldtets midlere afdeling mellem Guldalen og Meldalen. 8vo. Christiania, 1877.

Collins, J. H. The Geological Age of Central and West Cornwall. [Reprint from Journal of the Royal Institution of Cornwall, vol. vii., part 1, 1881.] 8vo. Truro, 1881.

Dewalque, G. Observations sur le Degré d'Avancement des Travaux de la Carte Géologique Détaillée de la Belgique. Réponses à M. A. Rutot. 8vo. Liége, 1882.

——. Sur l'Origine des Calcaires Devoniens de la Belgique. 8vo. Bruxelles, 1882.

——. Sur l'Origine Corallienne des Calcaires Devoniens de la Belgique. Replique a M. E. Dupont. 8vo. Bruxelles, 1882.

Geinitz, H. B. Zur Erinnerung an Eduard Desor Ehrenmitglied der Isis seit dem Jáhre, 1865. 8vo. Dresden, 1882.

Helland, Amund. Om Kromjernsten i Serpentin. [Saerskilt aftrykt af Vidensk-selsk. Forhandlinger, 1873.]

Kjerulf, Theodor. On Stratifikationens Spor. 4to. Christiania, 1877.

Liversidge, Archibald. List of the Scientific Papers and Reports by Professor Archibald Liversidge. 8vo. Sydney, N.S.W. N.D.

Liversidge, Archibald. The Minerals of New South Wales. Second Edition. Folio. Sydney, 1882.

Pengelly, W. Notes on Recent Notices of the Geology and Palæontology of Devonshire. Parts 8, 9. [From Trans. of Devonshire Association for the Advancement of Science, Literature, and Art.] 8vo. [Plymouth] 1881–82.

——. Eleventh, Twelfth, and Fifteenth Reports of the Committee for Exploring Kent's Cavern, Devonshire. W. Pengelly, Reporter. [From Reports of British Association, 1875–76; 1879.] 8vo. [London.]

Petterson, Karl. Profil gjennem Vestfinmarker fra Sörö-sund mod Vest til Porsanger mod Öst. 8vo.

——. Geologiske Undersögelser i Tromsö Amt. III. Om Kvartærtidens Dannelser. 8vo.

——. Geologiske Undersögelser inden Tromsö Amt og tilgrændsende Dele af nordlands Amt. IV. 8vo.

Purgold, A. Die Meteoriten des Königl. Mineralogischen Museums in Dresden. 8vo. Dresden, 1882.

Quaritch, Bernard. General Catalogue:

Part II.—Works on Natural History, Physics, Mathematics, and other Sciences. 8vo. London, November, 1881.

Part III.—Periodical Literature, Journals, and Transactions of Learned Societies, Issues from Government and Private Presses, Collections, &c. 8vo. London, May, 1882.

Reush, Hans H. En Hule paa Gaarden Njös, Leganger Præstegjæld i Bergens Stift. 8vo. 1874.

——. Grundfjeldet i Söndre Söndmör og en Del af Nordfjord. 8vo. 1877.

——. Iagttagelser over isskuret Fjeld og Forvitret Fjeld. 8vo. 1878.

Schary, J. M. von. Catalogue des Fossiles du Système Silurien du centre de la Bohême de la Collection du défunct J. M. von Schary à Prague. 8vo. [Prague] N.D.

[Presented by Mr. W. W. Smyth, F.R.S.]

CURATOR'S REPORT.

THE following have been added to the Museum during the past year:

	NAME AND LOCALITY.	DONOR.
1.	Galena crystallized on Quartz, Foxdale Mine, Foxdale, Isle of Man	Dr. C. Le Neve Foster.
2.	Scratched Stone from Glacial Drift, Deganwy, North Wales	"
3.	Ditto ditto ditto	"
4.	Ditto ditto ditto	"
5.	Graptolites in Slate (Caradoc group, Lower Silurian), Hendre Quarry, Roman Bridge, Carnarvonshire (a new locality)	"
6.	Teeth of Ox, and fragments of Horse teeth, Bone Cavern, Stonehouse, Plymouth	R. N. Worth, F.G.S.
7.	Portion of Lode, north part of Chapple's Lode, 332 fms. level, Cook's Kitchen Mine	R. J. Frecheville.
8.	Ditto, Dunkin's Lode, Cook's Kitchen Mine	"
9.	Ditto, Tincroft Mine	"
10.	Ditto, Carn Brea Mine	"
11.	Ditto, 352 fms. level, east of New East Level, Dolcoath Mine	"
12.	Ditto ditto ditto	"
13.	Ditto ditto ditto	"
14.	Ditto, 364 fms. level, west of Engine Shaft, Dolcoath Mine	"
15.	Ditto, bottom of Engine Shaft	"
16.	Weathered Stones, showing erosive action of wind-blown sand, Towednack, Cornwall	Thomas Cornish.

TREASURER'S STATEMENT, 1881-82.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

1881. November 4th.	£	s.	d.
To Balance	86	15	3
1882. December 15.			
To Donation from H.R.H. the Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears	80	17	0
„ Penzance Public Buildings Co., Acknowledgment of Lights	0	1	0
„ *Transactions*	4	8	0
	£192	1	3
To Balance	84	13	4

1882. December 15th.	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper	6	10	0
„ Insurance	2	12	9
„ Palæontographical Society	1	1	0
„ Printing	22	14	9
„ Assistant Curator	21	0	0
„ Sundry Bills	10	9	10
„ Expenses per Secretary and Treasurer	11	5	0
„ Gas Fittings	7	6	3
„ Donation to Science Exhibition	10	0	0
„ Painting, &c., per Borough Surveyor	14	1	4
„ Balance forward	84	12	4
	£192	1	3

W. BOLITHO, JUN.,
Treasurer.

29th December, 1882.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

DECEMBER 29th, 1882.

1. Notes on the Great Main Lode of Dolcoath, Cook's Kitchen, Tincroft, and Carn Brea Mines. By R. J. Frecheville, Assoc. Mem. Inst. C.E.

2. On the Mines of the Province of Rio Grande do Sul, Brazil. By Henry Eddy.

3. On the Nickeliferous Pyrites of Berg Nickel Mine, in the Island of Senjen, Norway. By Joseph Garland, F.G.S.

4. Notes on some Teeth from a Stonehouse Bone Cave. By R. N. Worth, F.G.S.

5. Notes on Aberllefenny Slate Mine. By C. Le Neve Foster, D.Sc., F.G.S.

6. On an Emanation of Carbonic Acid Gas at Foxdale Mine. By C. Le Neve Foster, D.Sc., F.G.S.

cleared in less than ten minutes; if greater speed is required two ventilators can be applied, and then the 'end' will be freed almost instantaneously from all the noxious gases generated by an explosion.

The advantages I claim for my apparatus are—

1. Simplicity, as there is nothing to get out of order, and as there are no working parts requiring supervision or even oiling.

2. Economy in first cost, as the only additions to the existing plant are the ventilating pipe and the connecting pipe, with its nozzles.

3. Economy in working, as no extra expense is incurred, because even in the ordinary course of working the compressed air is allowed to escape during the blasting operations.

4. Economy of time in driving, as the intervals between the successive volleys can be reduced to a minimum.

5. By the adoption of the outer pipe or pipes a saving of over thirty per cent. is effected.

6. Increased comfort and health to the workmen, as they are not exposed to noxious fumes.

Under these circumstances I trust that my plan of ventilating headings will be widely applied; and I feel convinced that its adoption will be of considerable benefit, not only to my native county, but also to other mining districts.

NOTE.—It is but right to remark that Mr. Teague's apparatus somewhat resembles Körting's ventilator, which has been used in mines with steam and compressed air for some years. A similar plan of ventilating a heading was adopted at Spring Valley Mine, in California; but the nozzle was turned towards the face, and drew in pure air from the mouth of the tunnel instead of exhausting the foul air. (*Mining and Scientific Press*, San Francisco, Dec. 31, 1881.)—Editor *Trans. Roy. Geol. Soc. Cornwall.*

NOTES ON THE

GREAT MAIN LODE OF DOLCOATH, COOK'S KITCHEN, TINCROFT, AND CARN BREA MINES.

By R. J. Frecheville, Assoc. Mem. Inst. C.E.
(One of H.M.'s Inspectors of Mines).

The paper which I have the honour to read before the members of this Society contains a brief sketch of the present condition of our largest and most productive tin lode, together with some valuable information very obligingly furnished to me by Messrs. Josiah Thomas, Charles Thomas, and William Teague, jun., the managers of the different mines on the run of the vein.

To the south of the town of Camborne, where the killas overlaps the northern base of the granite range of hills known as Carn Camborne, Carn Entral, and Carn Brea, the formations are traversed by the great main lode of Dolcoath, Cook's Kitchen, Tincroft, and Carn Brea Mines, which, together with its branches, produces about one-third of the total amount of "black tin" raised annually in the county, and is now being worked on continuously for a distance of about 2½ miles along its course, and to a depth in Dolcoath

Mine of 400 fathoms from surface on the "underlay," or 355 fathoms perpendicular.

The "strike" of this great lode, which goes by the name of the Main Lode in Dolcoath, Chapple's Lode in Cook's Kitchen, and the Highburrow Lode in Tincroft and Carn Brea Mines, is about 30° north of east, approximating closely to that portion of the line of the West Cornwall Railway connecting the towns of Camborne and Redruth. Its "underlie" is to the south, and varies considerably, being much flatter in the deeper workings than it is nearer surface. Thus in Dolcoath Mine, from the 290 fathoms level to the bottom of the "sump," the "underlie" is 4′ 6″ in the fathom; and in Cook's Kitchen Mine, from the 190 to the 345 fathoms level, it is 3′ 3″ in the fathom; whilst in both mines in the levels above, the "underlie" averages about 2′ in the fathom.

In the "country" south of the main lode there are several powerful branches also "underlying" south, but steeper than the main lode, so that in time they drop into it and serve to enrich it. Of these the most important are Dunkin's Lode and the South Lode, the former being known as Teague's Lode in Carn Brea.

These lodes all "crop up" within the killas ground at surface, but penetrate the granite at various depths, ranging from about 80 fathoms from surface at New Shaft in Carn Brea to about 130 fathoms from surface at the engine-shaft in Dolcoath, the line of division between the granite and killas thus appearing to incline to the N.W.

In the following remarks on the mines in which the main lode is being worked, the numbers prefixed to the levels signify their depth in fathoms on the "underlie" of the lode, taken from the adit level, which comes in at from 20 to 30 fathoms from surface.

In Camborne Vean, the western mine of the group, the engine-shaft has been sunk on the main lode to the 180. From that level a cross-cut has been driven to the south lode, on which a shaft has been sunk to the 282. Operations are now, however, confined to above the 140, to which level the mine is drained by Stray Park engine. The lode shows itself here strong and masterly, composed chiefly of capel (schorl-rock), quartz, and peach, with a very small admixture of tin oxide.

The adjoining sett to the east is Stray Park, which now, however, forms part of Dolcoath Mine. The engine-shaft is down to the 282; but nothing is being done underground, the pumping-engine being kept working merely for drainage purposes, this mine being connected with Dolcoath by a "winze" sunk from the 224 level in Dolcoath to the 238 level in Stray Park, on the main lode.

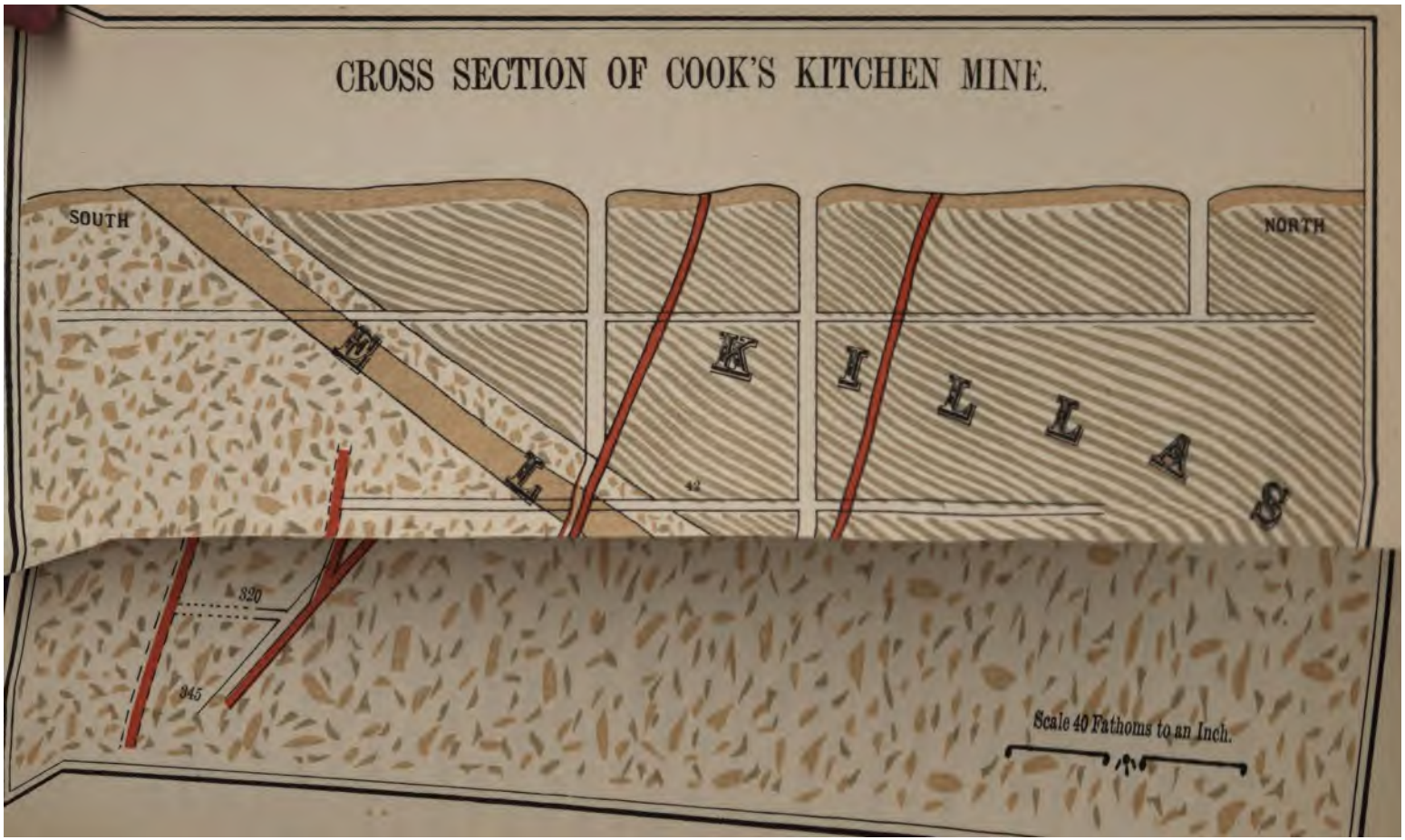
Dolcoath, by far the deepest and richest mine in Cornwall, has been so well described in a paper read by Captain Josiah Thomas before the Royal Cornwall Polytechnic Society in September last, that there remains little to say about it, except that in the bottom of the engine-shaft, and as far east and west as the 364 level has been extended, the lode shows

itself richer than at any previous time in the history of the mine. At the 364 level it is about 20 feet wide, and a large proportion of the lode-stuff, both here and in the bottom of the shaft, contains an average of about 10 per cent. oxide of tin to the ton of stuff. The importance of this becomes apparent when it is remembered that at the meeting of adventurers, on the 16th October last, it was stated that during the previous twelve weeks 16,000 tons of "tin-stuff" had been stamped and dressed, yielding 460 tons of "black tin," or 2·875 per cent. oxide of tin per ton of stuff.

A glance at the cross section, which is taken through the engine-shaft, will show the branches which have dropped into the main lode from surface down. The great improvement in the bottom levels may be ascribed to the influence of the south lode, itself a most important lode, which fell into the main lode at the 364 level. There are, however, two points connected with Dolcoath that are to a certain extent overlooked. East of New East Shaft the main lode is standing almost intact from the 230 down, the south lode having been chiefly worked on in this portion of the mine. Again, west of Old Sump Shaft, below the 190, there has hardly been anything done on the south lode. Now there can be little doubt, judging from the developments made on the main lode at the 352 level east of New East, and on the south lode at the 364 level west of Old Sump, that these unexplored portions of the mine contain valuable runs of productive ground.

The character of the lode-stuff in Dolcoath is well known. The richest ore consists of a compact, bluish-coloured rock, consisting of a mixture of peach, quartz, and schorl, with strings of oxide of tin running through it. The poorer parts are more capelly and of a blacker colour. Where chiefly composed of quartz, the lode is very poor. In the shallower levels the lode was much harder than it is at present. On the north or "foot-wall" side the lode has always a distinct and definite wall; whilst on the south side it passes gradually into non-stanniferous granite, without any clear and definite bounding-plane.

The granite in the deeper portions of the mine has a bluish colour for a couple of fathoms from the lode, and after that a greyish colour. East of New East Shaft at the 352 level, for about 50 fathoms in length on the south lode, the granite on the hanging-wall side is quite soft and decomposed, so that the level has to be closely timbered; and the lode presents, considering the depth from surface, an extraordinary appearance. It is full of "vugs," can be broken with the pick alone, and, being stained of a reddish colour with oxide of iron, looks, as an old miner remarked to me, just like the "back" of a lode. On the foot-wall underneath this soft ground the lode is extremely rich, and shows signs of great tranquillity, the peach, quartz, and tin oxide lying more or less in parallel layers. Luckily the occurrence of this very soft granite enclosing the lode seems to be quite local, the end of the 352 level east being now driven in hard ground. The granite showing in the 364 level


CROSS SECTION OF COOK'S KITCHEN MINE.
SOUTH
NORTH
H
L
K
I
L
L
A
S
42
820
945
Scale 40 Fathoms to an Inch.

and in the bottom of the engine-shaft is also hard and firm.

Cook's Kitchen Mine, to the east of Dolcoath, is separated from the latter by a cross-course filled with decomposed granite and clay, between 8′ and 9′ wide, nearly perpendicular, and coursing about N. 40° W.* This cross-course heaves the lodes from 70 to 80 fathoms to the right.

The cross-section of Cook's Kitchen Mine is taken through the engine-shaft, which is now being sunk below the 345 level.

Dunkin's Lode, which dropped into the main or Chapple's Lode at the 320 level, has immensely improved it, so that the mine, which for a time has been under a cloud, is now in the enviable position of having laid open and developed ready for stoping away, between the 332 and 345 levels, a very rich course of tin ore. The lode is from 15 to 20 feet wide. On the hanging-wall side the vein-stuff is of the same character as in Dunkin's Lode, consisting as it does of quartz, fluor spar, carbonate and oxides of iron, prian, and arsenical mundic, interspersed with tin oxide. On the foot-wall side the lode closely resembles Chapple's and Eudey's Lode, the tinstone being associated with capel (schorl-rock) and peach.

It may fairly be presumed that when the South Lode drops into Chapple's Lode its effect will be as beneficial in Cook's Kitchen Mine as it is in the case of Dolcoath.

* "Report on a Survey of the Mining District of Cornwall, from Chasewater to Camborne." By Richard Thomas. 1819.

That part of Chapple's Lode which in Cook's Kitchen Mine is known as Eudey's Lode becomes in Tincroft and Carn Brea Mines the main or Highburrow Lode, and is being sunk on in Tincroft below the 282, and in Carn Brea below the 284 level, fully maintaining its great size and strength, but being at present comparatively poor, although until quite recently it has been very productive. The bottom of the mine at Carn Brea, however, is now showing a decided improvement.

The ore is of very much the same character as in the mines previously noticed, except that it is somewhat redder, owing to a larger admixture of iron oxides.

Going east from Cook's Kitchen Mine into Tincroft and Carn Brea, Dunkin's Lode and the South Lode tend more and more to diverge from the main or Highburrow Lode, so that their junction with the latter will, in all probability, take place at continuously-increasing depths; and as the "ore shoots" follow the line of intersection of the lodes—that is, dip easterly—the continuance of the course of ore which now exists in the bottom of Cook's Kitchen cannot be expected in either Tincroft or Carn Brea, until those mines have attained a greater depth than they have at present. Of course, however, there are abundant chances of other courses of ore being meantime encountered, as also of the present developments proving satisfactory. Both of these mines have without doubt a grand future before them.

The magnitude of the operations past and present carried on in this run of mines, of which the great

main lode forms the chief artery, will be gathered from the following facts.

In the four mines—Dolcoath, Cook's Kitchen, Tincroft, and Carn Brea—the total length of the shafts and levels is 138 miles, of which 70 miles are in Dolcoath alone.

During the years 1872–1881 these mines have produced 32,430 tons of black tin, 6692 tons of copper ore, and 1908 tons of arsenic; and have paid in dividends £277,226 5s. The amounts of ore produced and dividends paid by each mine for the ten years are as follows:

	Black Tin.	Copper Ore.	Arsenic.	Dividends.
	Tons.	Tons.	Tons.	£ s.
Dolcoath . .	14,258	229	657	139,620 0
Cook's Kitchen .	2,300	28	70	10,106 5
Tincroft . .	6,894	336	127	97,500 0
Carn Brea . .	8,978	6,099	1,054	30,000 0
Totals . .	32,430	6,692	1,908	£277,226 5

The average price of black tin was—

	£	s.	d.	
In 1872 . . .	84	0	0	per ton.
„ 1873 . . .	74	7	6	„
„ 1874 . . .	55	15	0	„
„ 1875 . . .	49	15	0	„
„ 1876 . . .	42	12	6	„
„ 1877 . . .	39	12	6	„
„ 1878 . . .	34	5	0	„
„ 1879 . . .	39	0	0	„
„ 1880 . . .	52	5	0	„
„ 1881 . . .	54	12	6	„

or £52 12s. per ton for the decade.

In consequence of the period of depression passed through during the years 1875–1879 these mines, with the exception of Dolcoath, have made heavy calls on the shareholders, amounting in the aggregate to £56,950 for the years 1872–1881, of which amount Cook's Kitchen is debited with £26,950, Tincroft with £9,000, and Carn Brea with £21,000.

The number of people employed on surface and underground; the quantity of tin-stuff raised, stamped, and dressed; and the amount of water pumped annually; is given for each one of the four mines in the accompanying table, the average being taken in each case from a period extending over the last ten years.

	Number of People Employed Annually.	Quantity of Tin-stuff Raised, Stamped, and Dressed Annually.	Quantity of Water Pumped Annually.
Dolcoath . .	1,066	54,000 tons	2,120,000 tons
Cook's Kitchen .	225	12,000 „	185,000 „
Tincroft . .	472	29,000 „	289,000 „
Carn Brea . .	737	57,400 „	1,008,000 „
Totals . .	2,500	152,400 tons	3,602,000 tons

The average yield of black tin per ton of tin-stuff during the years 1872–1881 has been: In Dolcoath, 59 lbs.; Cook's Kitchen, 43 lbs.; Tincroft, 53 lbs.; and Carn Brea, 35 lbs. It is a question whether in some cases a closer selection of the tin-stuff underground would not have been beneficial, although the output of black tin would have been diminished.

The total cost of mining and dressing per ton of tin-stuff and returning black tin from same, as also these costs subdivided under their respective heads, during the period above mentioned, was for each mine as follows:

	Mining Cost per Ton.	Dressing Cost per Ton.	Total Cost per Ton.
	s. *d.*	*s.* *d.*	£ *s.* *d.*
Dolcoath . . .	16 11	3 10½	1 0 9½
Cook's Kitchen . .	16 4½	4 5½	1 0 10
Tincroft	13 9	4 8	0 18 5
Carn Brea . . .	14 3	3 9	0 18 0

These costs of mining and dressing include all possible charges; such as management, water charges, winding, labour costs, dead-work, merchants' bills, new erections, spalling, stamping, dressing, wear and tear, &c.

Taking into consideration the great depth of these mines, and the hardness of the ground, the above costs cannot be deemed excessive. A great deal has of late been said to the effect that the Cornish miners have degenerated, and that it is no longer possible to obtain from them "a fair day's work for a fair day's pay." This is, I am convinced, an unjust assertion, as is amply proved in those mines where proper supervision is exercised over the men and long contracts let to them.

During the last fifteen years I have been intimately acquainted with the Cornish miner, both at

home and abroad; I have also had many opportunities of comparing him with the miners of other countries; and I have no hesitation in saying that for intelligence and power of work he still remains, as he has always been, unrivalled.

This fact, together with the increased productiveness of our tin-lodes in depth; the continued improvements in our mining machinery; the valuable assistance rendered by boring-machines and strong explosives; and last, but not least, the greater attention paid to dressing operations, assures a long and prosperous future for the tin mines of Cornwall.

ON THE MINES OF THE PROVINCE OF RIO GRANDE DO SUL, BRAZIL.

By Henry Eddy.

The centre of the gold mining district of the province of Rio Grande do Sul is at the south-western extremity of the Serra do Batovy range of mountains (a continuation of the Serra do Herval range), and is situated between 30½° and 31° south latitude, and 10½° to 11° west longitude. The mountain range (which has an elevation of about 800 feet) is composed principally of granite, in which the proportion of felspar to the quartz is comparatively large. Near the surface it has a somewhat stratified look, which has led to its being called gneiss; but as depth is attained this disappears, and there is no doubt that the rock is really granite.

The surface of the granite dips both ways from Lavias, east and west. In a westerly direction the dip is about 4° to 5°, and comparatively little has been done in mining to prove any change. In an easterly direction the dip is about 2½° to 3°; but the height of the land is maintained almost uniformly for a considerable distance by the superposition of

other rocks, the principal of which is a fine laminated sandstone, highly coloured by oxide of iron. Patches of slate occur occasionally, and trappean rocks may be seen here and there. I fancy they are mostly trachyte.

Passing beyond the locality of the mining district in an easterly direction, the sandstone and slate are superposed by a conglomerate, its base being a sandstone highly coloured by oxide of iron, but containing quartz pebbles and small proportions of other foreign matter. The pebbles appear to have been derived from the quartz of the lodes.

There are numerous lodes in the district, consisting principally of quartz, but varying somewhat in composition, according to the nature of the enclosing rock or *country;* for as a rule they traverse the granite, slate, and sandstone without interruption. Their general direction may be taken as east and west, although they often vary from 10° to 20° from that direction; that is, 10° to 20° north of east and south of west.

The sandstone conglomerate, on the other hand, is of later date than the lodes, and is not ore-bearing, with the exception of containing occasional layers of copper ore. Alluvia derived from it are often auriferous.

Whilst enclosed in the laminated sandstone and slate the lodes produce ores of copper, lead, and silver. If there is a considerable thickness of these rocks above the granite, the upper parts of the lodes frequently contain copper ores only, and at the top

malachite, which may also be found extending for a distance of several yards into the country along joints. Below the malachite we find other ores of copper, such as melaconite, copper pyrites, erubescite, and copper glance, and with them more or less galena. If the strata with which these ores are associated have been laid bare by denudation, massicot appears as a product of the oxidation of the galena. In most cases the heavier ores of copper, as well as the lead ores, contain a small amount of silver.

As depth is attained in this series of rocks (sandstone and slate), traces of gold are found with the baser metals, but more particularly with silver. These traces increase on getting towards the bottom of the sedimentary rocks, and near the granite. The lodes pass into the latter rock without interruption, and then furnish principally gold.

The upper part of the granite, which has been exposed for some miles for a considerable period, is decomposed to a greater or less extent. This decomposition along the course of the lodes varies from 5 feet to 40 feet in depth, the least depth being where the lodes are small and hard, and the greatest where the lodes are large and moderately soft.

At a greater depth the lodes all become more solid, and the enclosing rock more regular and firm. The gold also gets finer and more evenly distributed. The granite may therefore be looked on as the permanent gold-producing rock of the district; while the rocks above produce copper, lead, and silver.

As a rule the lodes are richer (for the different ores)

in the slate than they are in the sandstone; and where the slate rested directly on the granite, the lodes in the latter rock are richer for gold than where the sandstone rested on it; or, in other words, the lodes contain a greater percentage of gold under the slate than under the sandstone. In some cases the gold extends up into the slate and sandstone, as already mentioned; but there is always a greater amount of gold in the former than in the latter rock.

There are a large number of patches of alluvial gravel and clay scattered over the district, most of which are more or less auriferous.

ON THE

NICKELIFEROUS PYRITES OF BERG NICKEL MINE, IN THE ISLAND OF SENJEN, NORWAY.

By Joseph Garland, F.G.S.

The Berg Nickel Mine has been worked by the head of a well-known smelting firm in England for the last ten years, and, notwithstanding the exceptionally unfavourable circumstances attending mining and smelting operations in a latitude considerably north of the arctic circle, the raising of nickel-bearing ore and its reduction to nickel regulus have been carried on with regularity, and on a considerable scale, during the whole of that period.

The mine and smelting-works are situated at Berg, on the north-west coast of the island of Senjen, in lat. 69°26 N., and long. 17°15 E.

Winter in this northern region is a long, dark, and dreary period, the sun remaining below the horizon for some weeks, and snow covering the ground till late in the spring. It occasionally happens that, owing to the severity of the storms, the sole means of communication with the outer world—the regular weekly mail steamer—is cut off for two or three weeks.

To compensate, however, for these drawbacks the

summer is very fine and very warm, the sun never setting for two or three months; and for about double this period there is daylight all night long. The climate is, therefore, one of extremes; but the cold is not so intense as the high latitude would indicate, owing to the moderating influence of the Gulf Stream. One evidence of this fact is, that the sea never freezes here.

Moreover, the darkness of the arctic night is a good deal relieved (the writer was assured during a recent visit) by the moon, the stars, and the beautiful aurora borealis.

The site of the mine is a low promontory, which rises about 80 feet above the sea-level. The workings are an open-cast from the ridge down to the first floor, 13 fathoms, below which the excavations are underground workings.

The general plan of working is to leave floors or arches 6 to 9 feet in thickness across the open-cast at intervals of about 6 fathoms, for the double purpose of securing the precipitous sides and keeping out the snow from the deeper workings. By adopting this method the use of timber for propping is rendered entirely unnecessary, an advantage gained by the sacrifice, temporarily at least, of a large proportion of the ore; viz., that contained in the arches or floors.

The deposit, which varies in width from 24 to 40 feet, consists of nickeliferous magnetic pyrites disseminated through gabbro; bunches and solid branches of the ore also occur. It has a strike or bearing corresponding with that of the promontory, about east

and west, and a dip south of about 70°. It shortens westerly, and has an easterly extension in depth.

The enclosing rock or *country*, like the deposit itself, is gabbro, and there is no regular foot-wall, nor hanging-wall, nor any continuous divisional plane, between them; and the limits of the workings are determined simply by the productiveness or otherwise of the ground.

The ore is magnetic pyrites, of a bronze-yellow colour, specific gravity about 4·5, and is slightly magnetic, being attracted by the magnet when pulverised. It is a sulphide of iron, but chemists are not agreed as to its exact formula, because there are sundry varieties. Various analyses have, however, determined the percentage composition to be about 60 of sulphur and 40 of iron. In the Senjen ore a portion of the iron is replaced by nickel, the richer ores containing 4 per cent., the crude ore-stuff, as delivered to the furnaces, after some imperfect sorting, averaging 1 to 1·2 per cent. of nickel. In this state it is conveyed to the smelting-works, where it is concentrated into regulus.

This is effected by three distinct processes.

The first consists in the melting of the crude ore, mixed with metal slag and coke, in a blast furnace. The resulting product, known as *first metal*, is broken down into small lumps and submitted to the second process—roasting.

A thick, hollow layer of firewood having been laid out on the ground, some 100 to 140 tons of *first metal* are heaped upon it, and the wood set fire to.

The combustion thus set going gradually extends, without further attention, throughout the whole mass. The effect of roasting, which takes four or five weeks, is to burn off the sulphur and to oxidise the metals contained.

A second roasting of the imperfectly-burned portion is necessary, and is usually effected in ten to fourteen days.

The third and final process consists in melting the *burnt metal* in a peculiarly-constructed furnace, termed a concentrator, the charge being a mixture of *burnt metal*, granite (this being the only convenient source of silica at hand), metal slag, and coke. The product is a regulus containing from 22 to 30 per cent. of nickel, together with a small, but by no means unimportant, quantity of cobalt and copper. The regulus is shipped to Swansea, as return freight, by the steamers which supply the works with coke, coal, and materials.

The mine and works have the great advantage of an abundant supply of water-power for pumping, winding, working the stone-breakers, driving the blasts, &c. There are also steam-engines equal to all the requirements of the establishment in reserve, in case of accident to the hydraulic machinery.

The climate and conditions under which these mining and smelting operations are successfully carried on furnish another proof of the enterprise of the English capitalist and of the skill and perseverance of the miner, who allows no difficulties to deter him from his explorations after the earth's metallic treasures.

NOTES ON

SOME TEETH FROM A STONEHOUSE BONE CAVE.

By R. N. Worth, F.G.S.

I have the pleasure of sending for the acceptance of the Royal Geological Society of Cornwall a few teeth of ox and horse from the most recently-discovered bone cave in the Plymouth district. I regret that the specimens are not more worthy of acceptance; but of the other animals whose remains were found there were hardly any duplicates, and a complete set has been deposited in the Museum of the Plymouth Institution.

The cave in question was a fissure in the limestone rock of the Battery Hill, Stonehouse, of great size, wholly filled with clay and earth of a surface character, through which the remains were scattered in a very fragmentary fashion. The fissure, which was at least sixty feet in depth from the surface, and probably much more, and the southward end of which had long been worked away before it was found to be of scientific interest, ran in the main with the north and south joints of the limestone, with a slight eastern underlie. It varied in width from two feet to twelve, and was evidently a tunnel cavern, eroded until its

roof fell in. Then a gradually-progressive filling commenced, in the course of which the remains were deposited which form the subject of this note. It is not likely that the cave was ever a den, but it must long have been a dangerous trap to the animals that roamed over the ancient plateau which it traversed.

Almost every bone found was imperfect, and the earth at several places was thickly charged with minute and obscure osseous fragments. The value, in a scientific sense, of the fissure is almost wholly dependent upon the teeth, which were found in what by comparison was a considerable quantity, though several species appear to be represented by one individual only. Thus there are remains of only one rhinoceros (*tichorhinus*), of one horse, one hyæna, one bear (*ferox*), one fox, one wolf, one cat, one dog, and probably one boar. At least, if these species are really represented by more than one individual, it is a very curious fact that their remains include no duplicates. There is also a single fragment of the dermal skeleton of a fish, probably the sturgeon, with bones of one hare and one black rat, and teeth of sheep or goat.

The cervine remains include bones of several deer of differing species, the most important feature of which is the occurrence of teeth of at least two reindeer (*C. tarandus*). More than one red deer are also represented, and possibly the roe-deer.

The only genus at all largely represented is the bovine; and here the species indicated are certainly *Bos primigenius* and *longifrons*, and in all likelihood

Bison priscus. Some of the teeth belong to very aged animals, and others to young ones.

The bones were found in very small quantities, at intervals extending over three years. Altogether nineteen species appear to have been represented in this one fissure; and one of these, the reindeer, had never been identified with the locality before. Of the nineteen, nine are either extinct or lost to this country.

I should like to add a word by way of comment—since the two sets of fissures are somewhat associated—upon the paper by Mr. N. Whitley, read at the last meeting of the Society, concerning the "Evidence of Glacial Action in Cornwall and Devon." While fully agreeing with him that there is evidence of that action in the West, I cannot recognize it in the so-called "drift" on Plymouth Hoe, with which I am perfectly familiar, and the latest development of which I had investigated before Mr. Whitley observed it in July, 1875. (It has been described by me both in the *Transactions* of the Plymouth Institution and of the Geological Society.) The two classes of Hoe phenomena which Mr. Whitley associates are, in my view, totally distinct: the "so-called 'raised beaches'" being really so; and the fissure deposits, which Mr. Whitley regards as glacial "drift," being really a simple detritus of Dartmoor origin, due to the action of water, which formerly flowed over the plateau. I have found precisely the same kind of deposits elsewhere in the neighbourhood of Plymouth, filling the fissures in limestone rocks, the coarser portions being

absolutely indistinguishable from the materials of the beds of the adjacent rivers. Moreover, the character of these deposits, in their association of fine sands and clays, wholly forbids the idea of any such agency of a cataclysmal character, as is commonly implied in the allusion to "northern drift." Undoubtedly, if we assign such a deposit to ordinary causes, we have to draw more largely upon the bank of time than if we assume the unusual; but that consideration cannot be allowed to outweigh direct evidence. I may add that my view was entirely endorsed, after personal inspection, by Professor Martin Duncan, F.R.S., late President of the Geological Society.

NOTES ON ABERLLEFENNY SLATE MINE.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

Aberllefenny Slate Mine lies about two miles N.E. of Corris, Merionethshire, near the mouth of a small valley, through which runs the Llefeni, a tributary of the river Dulas. The rocks of this district, which are of Caradoc age, consist of slate, interbedded with grits and sandstone, and form part of the zone of slaty beds which extends from Towyn, on the west, to Dinas Mawddwy, on the east.

The workings at Aberllefenny are carried on upon two of the *veins* of this district. I use the term *vein* in the sense given to it by miners and quarrymen, who often call any sheet-like deposit a vein. At the same time, to prevent any misapprehension, I may state that the veins of slate are in reality *beds*, *i.e.* deposits of sedimentary origin.

The principal vein worked at Aberllefenny has a thickness of 57 to 63 feet, and about 60 feet on an average. Its strike is from 34° to 44° E. of N. (true), and the dip is about 70° to the S.E.

Owing to the fact that the sides of the valley rise up to a height of seven or eight hundred feet above

the brook in the bottom, the vein can easily be attacked by adit levels.

The method of working a slate vein depends very largely upon the natural joints, the direction of the cleavage, and the nature of the roof. These features can best be explained by a diagram (fig. 1), which exhibits a cross-section of the main Aberllefenny vein. A is the so-called "spotted rock" lying under the vein. It is a hard spotted slate with an imperfect cleavage, and it often contains iron pyrites.

B is the vein, separated from A by a plane of stratification DE, known as the *bottom slip*. The cleavage planes of the slate vein dip in a contrary sense to the vein itself, and make an angle of 2° to 3° with the vertical. The strike of the cleavage planes is the same as that of the vein.

Above the vein, and separated from it by the plane of stratification FG, comes the *hard* C, a bed of bluish-grey argillaceous grit with interstratified thin beds of slate.

Running across the vein from wall to wall are more or less flat joints, known as *foot-joints*, marked *f*, *f*, *f* in the sections (figs. 1 and 2), and *back-joints*, *b*, *b*, *b*, *b* in fig. 2, which represents the two kinds of joints as they are seen when one is looking across the strike. The foot-joints are from 2 to 8 or 10 feet apart. The back-joints run from N.W. to S.E. (*i.e.* at right angles to the strike), and dip steeply either to the N.E. or S.W.

Lastly, we have to mention the important *line of pillaring*. The slate possesses the property of rending

Fig 1.

N. W. CROSS SECTION. S. E.

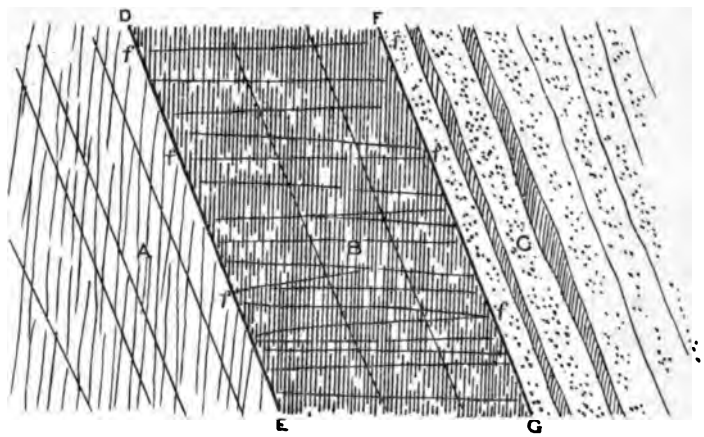
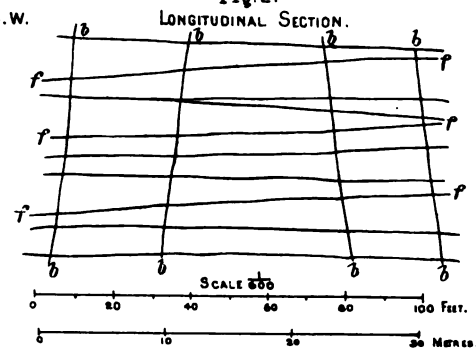


Fig. 2.

S.W. LONGITUDINAL SECTION. N.E.

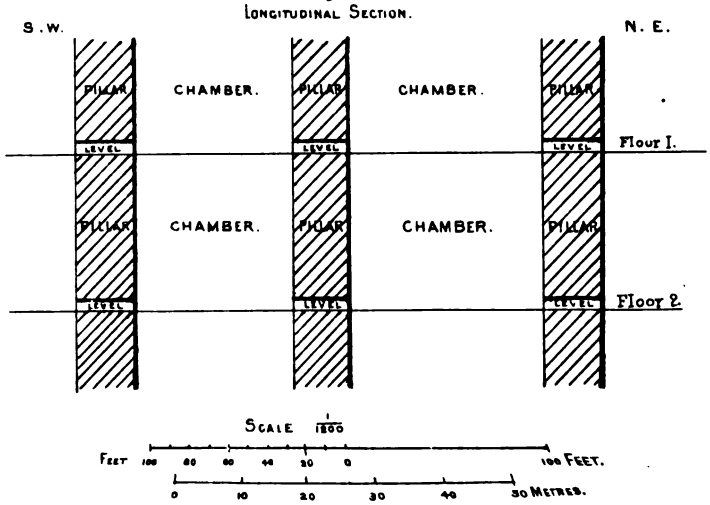


FIGS.– 1. 2. 5. 6. 7. 10. ARE ALL ON THE SAME SCALE.

Fig. 3.

LONGITUDINAL SECTION.

S.W. N. E.



along planes at right angles to the cleavage planes—in other words, in a N.W. and S.E. direction—and these planes of pillaring dip to the N.E. at an angle of about 80°; in fact, they are parallel to some of the back-joints. We have thus—1, the cleavage; 2, the foot-joints; and 3, the back-joints and the pillaring planes. The intersection of the two first sets of planes with back-joints or pillaring planes divides the slate into rough parallelopipeds.

These peculiarities of the Aberllefenny slate having been explained, I will now proceed to describe how the blocks are severed from the vein and conveyed to the surface.

The method of working may be described as that of alternate pillars and chambers following the line of dip. The pillars are from 24 feet to 30 feet long in the direction of the strike; whilst the chambers vary a good deal, some being as much as 100 or even 187 feet along the strike. Fig. 3 is merely a diagram, and no such regularity is followed in practice. If the vein were of uniform goodness throughout, such an arrangement would be possible; but as the back-joints are occasionally so numerous as to divide the rock into blocks which are too small for use, these valueless parts of the vein are not removed. Fig. 4 is a correct representation of the workings. The shading shows the pillars and the slate that is yet unworked, and the blank parts indicate the chambers which have been excavated.

The slate of the chambers is worked away in horizontal floors of slices from 44 to 150 feet in thickness,

starting from levels driven along the strike of the vein. The slices are removed in descending order, and the cavities produced are not filled up.

I will suppose that the vein has been worked away to the level AB (fig. 5), A being a gallery or tunnel along the "bottom slip." In order to commence the attack upon the next floor or slice, a level, C, is driven along the bottom slip, at a depth in this case of 80 feet below A. A shaft, CD, about 6 feet or 7 feet square, is then put through, partly by sinking and partly by rising. A strong chain is fastened across from side to side, and a block suspended at D, immediately above the centre of the shaft, and a powerful winch erected in the level A, with a chain passing from its drum through the block, and hanging from the shaft. All is now ready for removing the slate.

A trench about 4 feet wide, called the *opening* (fig. 6), is blasted out all along the foot-wall side, and carried down till a foot-joint is met with (fig. 7, *f*,*f*). A second trench, also about 4 feet wide, known as the *loose end*, is then excavated across the vein (fig. 6), and the slate is free for a certain depth on three sides. The *rock-men*, or men employed in removing valuable slate, now take the place of the *miners*, who do the preliminary work of making drivages and cutting the openings and loose ends.

The rock-man endeavours to get off block after block of slate, taking advantage of the joints and planes of splitting. He first of all produces a split along the cleavage planes, about 6 feet from the

Fig. 4.

LONGITUDINAL SECTION OF ABERLLEFENNY SLATE QUARRIES.

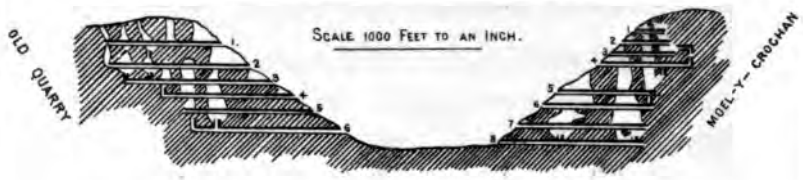


Fig 5.

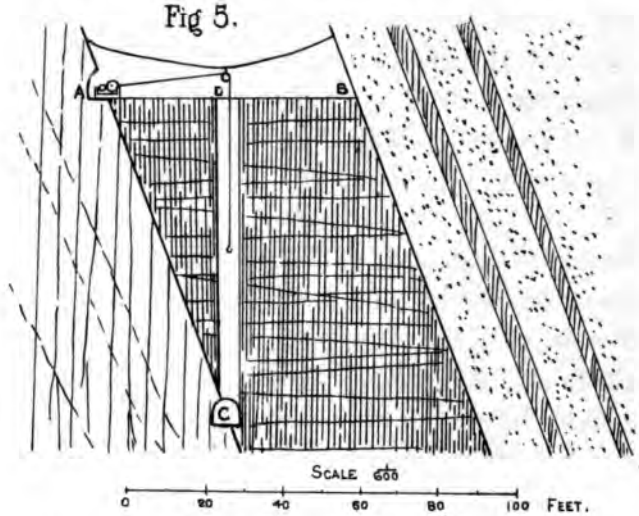
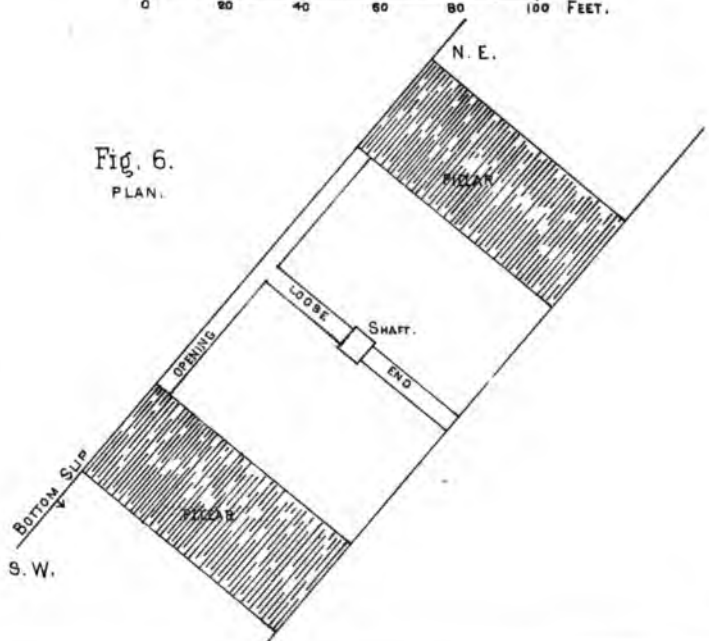


Fig. 6.

PLAN.



opening. This is effected by boring or jumping a hole A (fig. 8) along the line of cleavage, and reaching down halfway to the next foot-joint, or occasionally to the foot-joint itself. The hole is charged with 2 or 3 inches of powder, lightly tamped, and fired. The blast causes a crack along the line AB. If the crack is not large enough to effect the desired severance, the hole is re-charged, and fired once more. In order to set the block completely free, it is now only necessary to produce a rent along the line CD. If a suitable back-joint exists, the rock-man naturally avails himself of it, and by driving in wedges finally detaches the block from the parent bed. If no suitable back-joint can be found, recourse is had to the property of *pillaring*, or cross-rending, already alluded to. A groove about an inch deep is cut along the line CD, and wedges are driven in until a cross rent is produced which extends to the foot-joint below. It may happen that there is a difficulty in forming the desired fissure, and in this case a hole is bored in horizontally from the opening (fig. 9) in the direction of the *pillaring*, and charged with powder very nearly to the top. About 2 or 3 inches only of tamping are put in, and the hole is fired. The result of the blast is a crack along a pillaring plane, and the block can now be thrown down by means of wedges and crowbars. The workmen then split it by wedges along the true cleavage into blocks weighing 2 or 3 tons. A chain is passed round each block, and hooked on to the winding-chain. After being raised and swung over the shaft, it is lowered on to a

trolley in the level, and trammed outside. By means of self-acting inclines the loads are lowered to the mill-floor to be made into slabs, or are split into roofing slates in sheds near the entrances to the tunnels. Block after block is detached in the manner described, and after sufficient space has been cleared the opening and loose end are deepened to a second foot-joint; so that in time the workings present a step-like outline, as shown in fig. 10, which represents a slice or floor, between two levels A and C, about half worked away. Of course, whilst the slice AC is being removed another level should be in course of drivage for the purpose of working away the next horizontal slice below C. The workings in the main Aberllefenny vein are prosecuted on both sides of the valley. Those on the N.E. side furnish a slate well adapted for slabs, whilst the S.W. part of the vein produces a good roofing slate.

The slate blocks destined for slabs are split into slices about 3 inches thick, and then sawn by circular saws into rectangular form. These pieces are finally split to the desired thickness, and after having been planed are fit for the market. In the year 1882 Aberllefenny Slate Mine employed 101 hands underground and 74 above ground, and produced 4656 tons of dressed slates and slabs.

In conclusion, I desire to express my thanks to Mr. David Jones, the manager of Aberllefenny Slate Mine, for his kind permission to publish these notes, and to Mr. Michael Roberts, the resident agent, for much useful information concerning the workings.

Fig. 7.

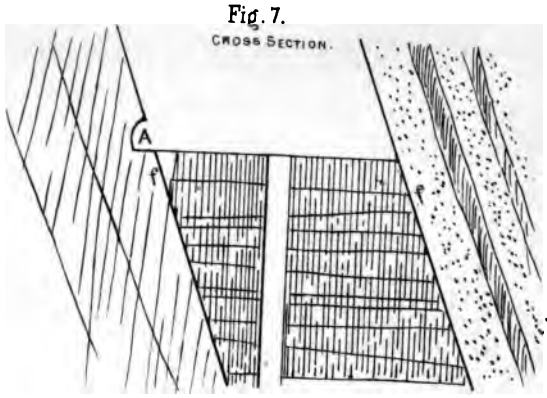
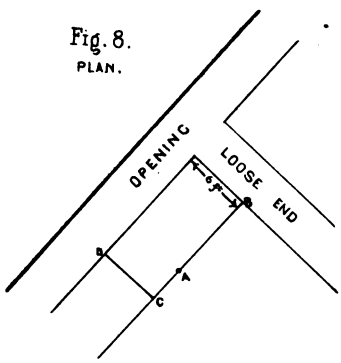


Fig. 8.



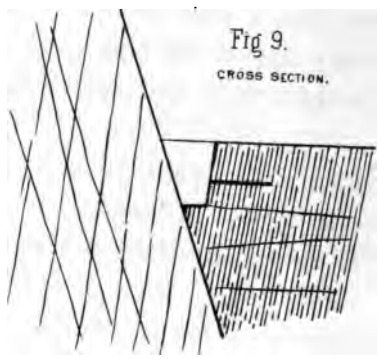
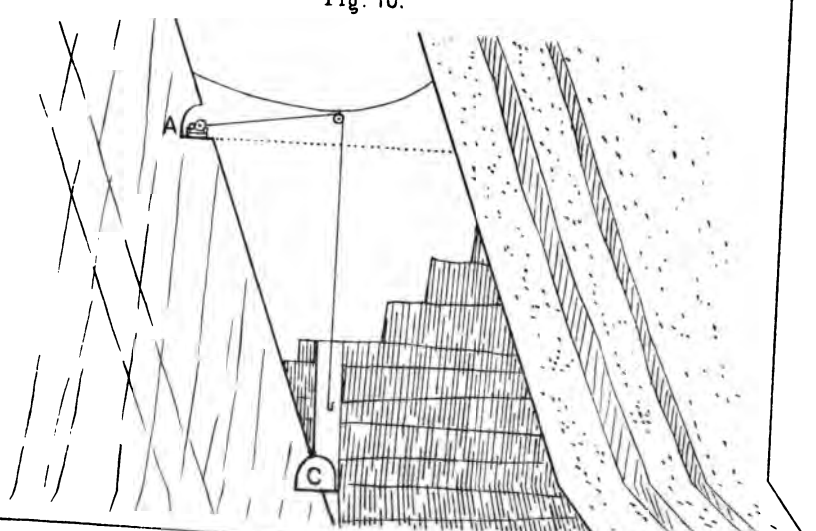


Fig. 10.



AN EMANATION OF CARBONIC ACID GAS AT FOXDALE MINE, IN THE ISLE OF MAN.

By C. Le Neve Foster, B.A., D.Sc., F.G.S.

While visiting Foxdale Mine last autumn I noticed a very distinct issue of carbonic acid gas in one part of the workings, and I think the fact is worthy of being placed upon record.

At the 185-fathoms level a cross-cut had been driven about 14 fathoms from the lode in a southerly direction, both the lode and the cross-cut being in granite. I found water flowing freely from small fissures; and on holding a lighted candle near some of the fissures, it was immediately extinguished by some invisible gas. As the gas would not support combustion, and as ½ cubic inch of it gave a very decided precipitate with baryta water, I came to the conclusion that it was carbonic anhydride. This opinion was confirmed by an analysis of the water made for me by my brother, Mr. Herbert Le Neve Foster; for he found that it contained 6 cubic inches of free carbonic anhydride to the gallon.

A somewhat similar issue of gas was observed in the neighbouring Townshend Mine, in the sole of the 80-fathoms level, about three years ago. It came

from a "loch," or "vugh," but ceased at the end of about a fortnight. At Great Laxey Mine small emanations of carbonic anhydride from "lochs" have been reported to me. At some of the Shropshire lead mines, viz., Pennerley and Roman Gravels, the same phenomenon has occurred, and it is not unknown in Cornwall. However, in none of these cases, as far as I am aware, has the issue of gas been so strong or so lasting as at Foxdale Mine. In the Alston Moor district, on the other hand, according to Mr. Wallace,* the quantity of carbonic anhydride discharged both by the veins and by workings in the surrounding rocks is occasionally very considerable.

* "The Laws which Regulate the Deposition of Lead Ore in Veins." London, 1861, p. 130.

Royal Geological Society of Cornwall.

THE SEVENTIETH

ANNUAL REPORT

ETC. ETC.

PENZANCE
1884.

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Mrs. Williams, Carhayes Castle, St. Austell.
George Williams, Scorrier.

ASSOCIATES.

Arundel Anthony, Lelant.
James Bennetts, North Levant Mine, St. Just.
J. T. Blight, F.S.A., Penzance.
J. H. Collins, F.G.S., Rio Tinto Mines, Huelva, Spain.
Wm. Eddy, Boscaswell, St. Just.
James Evans, Nance, Illogan.
John Giles, East Looe.
William Gregor, Swansea.
R. T. Hall, formerly of Cape Copper Mines, Africa.
William Hollow (formerly Manager of the Providence Mines), Leyton, Essex.
Benedict Kitto, F.G.S., The Assay Office, George Yard, 36, Upper Thames Street, London, E.C.
S. Michell, Swansea.
Francis Oats, F.G.S., Diamond Fields, Kimberley, S. Africa.
John Phillips, Australia.
T. B. Provis, As. In. C.E., Camborne.
John Rowe, The Terrace, St. Just.
Stephen Thomas.

Names of Honorary Members, Life Members, and Associates whose Addresses are unknown.

John F. Cunningham, F.G.S. | Thomas Hawkins, F.G.S.
Thomas Adair Masey, F.G.S.
Hall, R. T. | Phillips, John.
Thomas, Stephen.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—When I appeared before you last year I had to confess with the utmost frankness that I had no claim whatever to your attention as a geologist. I recognised the fact that you of your kindness had asked me to fill a post I was unqualified to occupy, out of certain local regard, and I hope I might say respect, because my connections are so intimate with the town; but as far as scientific attainments were concerned I had no right to occupy the chair. My time since that meeting has not been so free from engagements that I have been able to make myself what I was not then—a geologist; and consequently I have to appear before you a second time making the same confession I was obliged to make last year.

I am somewhat puzzled to know in what fashion to address you now. Last year I was able to take the position of one who had no special acquaintance with geology, who came here before many professed students of the science to explain in what way I, as a mere ordinarily-educated person, was able to recognise and acknowledge the many obligations I owed to those who studied geology; the way in which that study affected, I might say, the thought of educated men, so as to alter the scope and range of many of their ideas, and to produce in them an elevation and expansion of thought to which they would otherwise be strangers. It would be impertinent in me to go over the particular line then followed; but having regard to my want of special qualifications for any professional address,

I thought I might at this time take up one special thought, and show what a change and transformation has been brought about in our way of thinking by the study of geological science.

Now, in what might be called the pre-scientific era—an era the late Lord Derby said he was born in—nothing was more common in the literature and thought of the time than the idea of the permanence of outward forms of nature. Man, contemplating his own comparatively brief sojourn on earth, was represented as contrasting it over and over again with the enduring outline of the scenery and the country in which he was placed. All of us must recollect how often this occurs in the writings which are common to us, and which we regard with the highest veneration—how the transitory life of man is contrasted with the permanence and enduring quality of the forms of outward nature. "That ancient river, the river Kishon," struck one of old as something almost eternal in its constant flow, and the reference to the "everlasting hills" seems to show a great sense of the permanence of the forms of outward nature.

It is, of course, true that it became early known that the superficial aspect of nature was under a constant change and flux. The winds waste, and the waters wear; and, as has been shown by a great man of science recently passed from among us, the mere earthworm, so humble and obscure, transforms the whole surface of the earth in which it labours. But with this constant flux and change there remains an apparent permanence of the outline of nature. It is the result of the study of geology to convince us that outward nature itself is subject, and has been subject, to very considerable changes, and that what we regard as a solid resting-place on which we play the little act of our lives, even the small space which we fill, is also under continual change.

I am now speaking of the changes concurrent with the existence of man, not of the changes that befell this planet before man might be assumed to have appeared on it, which were of the most

violent character. Concurrently with our own time—indeed in the past year—we have had evidence over and over again of considerable changes in the surface of the earth, showing that the permanence, endurance, and stability on which primarily man was supposed to rest, and has rested in confidence, are subject to perpetual mutation.

Before going into any detail, I might refer to a little incident of my own experience, which happened some twelve years ago. When, with my sisters, I was going up the slopes of Vesuvius, we crossed a flow of lava which had issued from the mountain at least fifteen years before. We walked over it. It was perfectly hard and solid, apparently as hard as the pavement of your streets, but here and there cracks were visible in it. When we looked well into the cracks we discovered a little gleam in the bottom, and on a walking-stick being thrust in to a depth of some twelve or eighteen inches, the stick came out charred and smoking. In fact we were walking on what was below a perfectly hot, viscous substance. It struck me as very remarkable that, after the lapse of so many years, and at such a short distance from the earth's surface, there should be this evidence of intense activity and heat; and the permanent character of the eruption—its ability for years and years to retain such a quantity of heat that portions of wood dropped into it at so small a distance from the earth's surface became charred—gave us of course some idea of the immense activity of the same substance when it issued forth. If such a retention of heat and power is possible, we are easily carried to the thought that under a comparatively thin crust of this earth there may exist a state of activity and excitement such as we could only have a conception of by the occasional outburst of those vents, through which the internal matter in commotion was poured upon us.

During the last year we have had some considerable evidence of remarkable activity in the neighbourhood of scenes of the greatest beauty, and inhabited by a people of the highest civilization. We must all have been struck by the terrible contrast between the

charm of the Sunday evening when the Ischians were enjoying the beauties of the Bay of Naples, and the scene which followed—the awful earthquake, resulting in the loss of so many human lives, and the destruction of so many buildings. Still more recently there has been a tremendous disturbance in the Straits of Sunda, which depressed some mountains, elevated others, altered the channel of the sea, overthrew lighthouses, removed landmarks, and overwhelmed thousands of human beings. So within the last three or four days we have had intelligence of considerable destruction of life and property in the immediate vicinity of Smyrna, in the archipelago of Asia Minor.

These extraordinary evidences of underground agency and force lead us to think very little of the primary idea of the permanence and endurance of the forms of outward nature to which I referred as belonging to the older literature. If we put together the investigations and discoveries of geologists, we see that even now the earth is possessed by a subterraneous force working outward, in some places constantly, in others intermittently, with very slight periods of rest. The dead earth is still living. What was supposed to be immovable is in a state of flux; what was supposed to be rigid and permanent is liable to perpetual changes.

But what I have stated is not, of course, in its application confined to mere earthquakes or volcanoes. We have even in our own country evidence of internal heat in the hot springs to which people resort for purposes of health, and which have been known for thousands of years—springs which are remarkable as being so far distant from the centres of volcanic energy, and which yet show that under the surface there may be something of the same volcanic action perpetually going on elsewhere. If you inspect a series of physico-geographical maps, you will see the world is now enringed by volcanic action; while if passing into remote antiquity you were to see the evidences of the forces that had existed and had manifested themselves, you would find that there is scarcely a part of the world which is not studded over with the signs of past eruptions,

all of which can be recognized by the skilled, and many indeed by the unskilled, geologist.

The investigation of the causes of these phenomena would lead into very considerable labour, and I am happy here at all events to be somewhat on the same platform with the geologist proper, because I believe geologists themselves are unable to give any complete explanation of the causes of the phenomena in question. But there is one thing which apparently we must dismiss altogether—the notion which prevailed at one time, that underlying a comparatively thin crust of the earth there is found nothing but a great mass of molten fluid; that the earth is itself a crust surrounding this fluid mass. The suggestion is at first sight plausible, because it explains so many of the phenomena of volcanoes, hot-water springs, and earthquakes with which we are familiar; but it is demonstrated as a mathematical problem that such could not be —that, even with a rigid shell, the pressure of the movement of the fluid matter within such a thin crust, consequent upon the variation involved in the movement of the earth around the sun, would make it impossible to maintain the equilibrium of the whole. We must therefore dismiss this hypothesis, for that reason is absolutely convincing and demonstrative.

But the other suggestion which now appears to find favour with geologists—that the earth, although solid, is at points of extreme tension and pressure liable to become fluid and hot on the least alteration of the pressure against the thick rind of the earth—seems to be the best explanation of the different phenomena of movements of the earth and the effects of volcanic action with which we are familiar.

Still, whether we adopt the one cause or the other, we arrive at the same feeling with respect to the earth itself—a feeling passing away from that older one to which I referred at the outset, and recurring to one to which the ancient Greeks gave utterance in their legend in which they explained the tremors of Etna, that

some huge giant, who had been overthrown in a war with the gods, had been put into prison below the earth, and that his attempts to escape produced the earthquakes, volcanoes, noises, movements and tremblings of the earth. We have within the globe a giant who is perpetually attempting to break forth, and who does break forth; but at the same time the extraordinary balance of forces which we see in every part of nature results in an equilibrium which allows us to pursue our daily work, though we are convinced that there is a perpetual movement of nature around us.

I must conclude by apologising for the character of my observations, which, however, have the merit of having been intended merely for what they really are—the simple ideas of an ordinarily educated man, musing over the phenomena which are more elaborately studied by the professed students of geological science.

REPORT OF THE COUNCIL.

THE Society has now attained the seventieth year of its existence, and seeing that it is active and vigorous, it is with particular pleasure that the Council present this, their Seventieth Annual Report. During the past year numerous additions have been made to the Library; and the donations to the Museum, though not numerous, are especially noticeable for a large piece of silver ore from Potosi, perhaps the most intrinsically valuable specimen in your collection, presented by Captain Penberthy. In accordance with the wishes expressed last year, your Council have resolved upon holding this meeting in the afternoon, and it is hoped that the time will be more convenient to the majority of members. With regard to the progress made by the Science Classes, under the guidance of Messrs. Barnett and Corin, you will have an opportunity of hearing a detailed account at the distribution of prizes, which will take place this evening in St. John's Hall. It will be sufficient to say here that the success which has attended them is very gratifying. Since last we met the Society has to regret the loss of one of its oldest honorary members and benefactors—Dr. Henry Boase, of Dundee, who died on the 4th May at an advanced age. It is only necessary to examine the cases around you to see how largely he added to the collections at a time when he was more intimately connected with this town, and with this Society. He was a prolific writer upon geological and other subjects. The Council beg to recommend the election of Mr. John Bernard Magor, of Penzance, and Mr. Richard Foster Bolitho, of Ponsandane, as ordinary members of this Society.

GEORGE BOWN MILLETT,
Honorary Secretary.

PENZANCE, 19*th October*, 1883.

LIBRARIAN'S REPORT.

THE following works have been added to the Library:

I. TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies, Editors, and other Donors, or purchased.

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II. Serie. Band viii., Heft 4. 8vo. Dorpat, 1882.
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8vo. London, 1883. *Purchased.*

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Parts 1, 2, 8, and 11 of vol. xiii.
Part 17 of vol. xiv.
Parts 3–9 of vol. xvii.
8vo. Salford, 1873–83.

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——. Note on certain Black Quartz Crystals from Boscaswell Downs, Cornwall. [*Ibid.* No. 4, 1877.] 8vo.

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Ussher, W. A. E. The Recent Geology of Cornwall. [From Geological Magazine, January to July, 1879.] 8vo. London, 1879.

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[A large number of the above presented to the Society by Mr. Ussher for Distribution.]

Whitaker, William. Supplementary List of Works on the Geology, Mineralogy, and Palæontology of Devonshire. [Reprint from Transactions of Devonshire Association for the Advancement of Science, Literature, and Art, 1872.] 8vo.

——. List of Works on the Geology of Cambridgeshire. 8vo. Cambridge, 1873.

——. List of Works on the Geology, Mineralogy, and Palæontology of [the] Hampshire [Basin]. [Reprint from Journal of the Proceedings of the Winchester and Hampshire Scientific and Literary Society, 1873.] 8vo.

——. Guide to the Geology of London and the Neighbourhood. [An Explanation of the Geological Survey Map of London and its Environs, and of the Geological Model of London in the Museum of Practical Geology.] 8vo. London, 1875.

——. List of Works on the Geology, Mineralogy, and Palæontology of Cheshire. [Reprint from Proceedings of the Liverpool Geological Society, 1875–76.] 8vo. Liverpool.

——. List of Works on the Geology of Hertfordshire. [From Transactions of the Watford Natural History Society, March, 1876.] 8vo.

CURATOR'S REPORT.

THE following specimens have been added to the Museum during the past year:

	NAME AND LOCALITY.	DONOR.
1.	Magnetite, Naseberg Mountains, Lapland .	W. Barry Lord, per T. Cornish.
2.	Apatite (Phosphorite), Grand Duchy of Nassau Mines	
3.	Large piece of Silver Ore, weighing over 3 cwt. (consisting principally of Argentiferous Galena, Blende, Fahlerz, and Gangue). Huanchaca Mining Co.'s Mines, about 120 miles S.W. of the Potosi Mountains, South America (13,000 feet above sea-level) .	Capt. J. Penberthy.
4.	Earthy Bismuth (mixture of Carbonate and Oxide). Chorolque Mountain . .	"
5.	Fossil (Ammonites communis). Found on the surface, Caracoles Mining District, Desert of Atacama, at about 8,000 ft. above sea-level	"
6.	Schorl Veins in Granite, near Ding Dong, Madron	W. Ambrose Taylor.
7.	Highly-altered Granite, showing perfect Pseudomorphs of Schorlyte (Schorl and Quartz) after Felspar. Alverton, Penzance . .	"
8.	Trowlesworthite, Trowlesworthy Tor, Dartmoor	R. N. Worth.
9.	Specimen of highly-altered Slate, traversed by Quartz Veins. Peculiar shape of specimen is owing to fracture along cleavage-planes	T. Cornish.

TREASURER'S STATEMENT, 1882-83.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

1882.	£	s.	d.
To Balance	84	12	4
1883. October 19th.			
To Donation from H.R.H. the Prince of Wales	20	0	0
„ Ordinary Subscriptions and Arrears	77	14	0
„ Sale of *Transactions*	1	16	10
	£184	3	2
„ Balance	61	4	11

1883. October 19th.	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper	3	5	0
„ Insurance	2	12	9
„ Subscription Palæontographical Society	1	1	0
„ Printing and Stationery	71	6	6
„ Assistant Curator	15	15	0
„ Ditto Donation	5	0	0
„ Sundry Bills	8	10	0
„ Donation to Science Classes	5	0	0
„ Expenses per Secretary and Treasurer	10	0	0
„ Balance forward	61	4	11
	£184	3	2

19th October, 1883.

W. BOLITHO, JUN.,
Treasurer.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

OCTOBER 19th, 1883.

1. On Trowlesworthite, etc. By R. N. Worth, F.G.S.
2. On the Ancient Metallurgy of Cornwall. By Alfred Tylor, F.G.S.

It has been since notified to the Secretary that a paper is nearly completed by Messrs. Alexander Somervail and Howard Fox, "On the Occurrence of Volcanic Tuffs and Agglomerates among Strata of Caradoc age in the Meneage District," and it is hoped that the communication will be read at the next Meeting of the Society.

ON TROWLESWORTHITE,

AND CERTAIN GRANITOID ROCKS NEAR PLYMOUTH.

By R. N. Worth, F.G.S.

I have had the pleasure of forwarding, for the Museum of the Royal Cornwall Geological Society, a specimen of a rock which I believe to be quite new to petrologists, and which I have named—from the place where it was found by me in August last—Trowlesworthite. One loose block, and only one, could be discovered, after most careful and repeated search, on the north-western flank of Trowlesworthy Tor, which rises on the skirts of Dartmoor, near Cadover Bridge, above the river Plym, there commonly called the Cad. The tor is in mass red granite of varying shades, and has been quarried for ornamental purposes at different times. The block of Trowlesworthite I take to be a fragment of a vein traversing the granite, but hidden by the turf, and, like the well-known Luxulyanite, which it somewhat resembles, not to be found *in situ*. The resemblance to Luxulyanite consists in its being mainly composed of tourmaline and felspar; but the difference is even more material—the presence of violet fluor spar. Moreover the felspar, which is flesh-colour in Luxulyanite, in Trowlesworthite is a rich

red; and this, contrasting with the velvety-black of the tourmaline and the deep violet of the fluor, makes Trowlesworthite a rock of rare and singular beauty.

The occurrence of fluor spar in association with *granite* is not a new discovery. Dr. Boase noted it many years since in the Hensbarrow boss, and it occurs also in china stone. Moreover some of the German granites, but very rarely, contain this mineral. Trowlesworthite is not, however, granite, hardly granitoid by courtesy. The mica, which is one of the invariable components of true granite, is absent altogether, and the quartz is present only in very small quantity. Tourmaline (occasionally present also in distinct crystals) seems in part to form a kind of ground-mass, and some of the smaller crystals of felspar are scattered throughout this in such a manner as to present a strangely brecciated appearance. If we are to regard Trowlesworthite as akin to Luxulyanite plus the fluor, it will also in all probability be an altered rock; but on this head I have at present no evidence to offer.

Though not directly connected with this subject, perhaps it may be well to put upon record here also the discovery of a small boss of granitoid rock, chiefly felspathic, with needles of schorl, just on the verge of the ancient limits of the county of Cornwall, on the eastern side of the Tamar, near King's Tamerton and St. Budeaux. Associated is a micaceous rock, which may be a mica trap, or an altered portion of a band of greenstone. These rocks were noted as peculiar by the late Mr. John Prideaux over half a century ago,

but the granitoid character of the former seems never to have been suspected until the exposure was examined by myself, early in the present year. With reference to my note of the discovery of gneiss in the Shovel Reef, in Plymouth Sound, read to this Society at its meeting in 1880, I should also wish to state that evidence has since been obtained which negatives the idea that there is any gneiss in that portion of the reef on which the Breakwater Fort is built. The historical evidence for the correct assignment of the specimens on which the announcement was made to the reef, remains, however, unshaken, and a careful examination of the shores of Plymouth Sound, while failing to reveal any direct traces of the existence of granitoid or gneissic rocks *in situ* there, has shown in addition to the "contortions and displacements" of an upheaving force close at hand, just such evidences of metamorphic action as we might expect to find on the hypothesis of the gneissic character of part of the Shovel Reef. I associate this with the granitoid rocks of King's Tamerton and St. Budeaux, because each seems to me a link between the granite highlands of Cornwall and Devon and the submarine granitic area of the Channel.

NOTE.—Since this paper was read, the Rev. Professor Bonney, F.R.S., F.G.S., to whom I am under a deep debt of gratitude, has made a microscopic examination of the Trowlesworthite, and has supplied me with a detailed statement of the results of his investigations, which he has kindly permitted me to publish. It will be seen that Professor Bonney's conclusions are of very great scientific interest and value.

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ON THE

MICROSCOPIC STRUCTURE OF TROWLESWORTHITE.

By Prof. T. G. Bonney, D.Sc., F.R.S., F.G.S., etc.

This very beautiful rock is rather coarsely crystalline, as is usual with the granite of Devon and Cornwall, and consists of red felspar, apparently orthoclase, dull green patches of schorl,* and purple fluor spar, with an occasional grain of quartz. The felspar is rather the most abundant mineral. Of the other two constituents, the fluor slightly predominates over the schorl; and, on examination with a lens, the latter appears often to border the former, and, when it occurs in larger patches, to be an aggregate of minute crystals associated with some other mineral. Under the microscope the felspar is seen to be rather decomposed, much stained with ferrite, containing numerous secondary microliths, some being tourmaline, the last often being associated with little patches of clear quartz. The tourmaline occurs, as in Luxulyanite, in two forms. 1. A moderate-sized grain of brown tourmaline, with a border of black dust

* I will use this name throughout for the black or dark green acicular variety of tourmaline.

mingled with a dark blue mineral, and a little quartz in minute crystals. This brown tourmaline contains several small enclosures. Several of these appear to be empty cavities; but in one is a small bubble, which does not appear to move. 2. Very numerous acicular crystallites of dull olive-green, or slightly brownish green-grey tourmaline (schorl), sometimes about $\frac{1}{200}''$ long, generally less. These are strongly dichroic, being a pale olive-brown when the optic axis of the crystallite is parallel to the vibration plane of the lower nicol (the analyser being removed); but, when it is at right angles, a dark greenish-grey, approaching black. This schorl is more abundant on the edges of the decomposed felspar crystals, growing from them like a grass, and is sometimes associated there with opacite and ferrite, so as to form an almost opaque mass. Many of the crystallites are elongated prisms, terminated by faces of R or $\frac{1}{2}$ R. They are associated either with quartz or fluor, into which they pierce, and through which they are scattered. The quartz is in moderate-sized granules, and is generally free from inclusions, cavities included.* The crystallites of schorl not seldom pierce it without interruption from grain to grain. The fluor shows a distinct octahedral cleavage, and is slightly stained with ferrite. Cavities are fairly abundant. They vary considerably in size, often ranging from about ·001 of an inch downwards, but sometimes exceeding the former magnitude. They are rather variable in form,

* A speck of ferrite or a cavity, measuring about ·0008 of an inch, with a bubble about $\frac{1}{6}$ of its volume, occasionally occurs.

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and commonly contain bubbles. These vary much in size; not seldom, however, they occupy about one-sixth of the cavity.

The habits of the tourmaline in Trowlesworthite are exactly such as I have described in the case of Luxulyanite,* and fully confirm the views there expressed as to the origin of that rock. This, which is hardly less beautiful, is certainly not easier to explain. The fluor is distributed among the felspar in the same way, and in about the same amount, as the quartz usually is in the normal granites of the region. The last mineral is rare in grains of any size, though the microscope shows that it is often masked by the crystallites of schorl. If in this case the quartz grains associated with the schorl are original constituents, then at the time when that mineral was forming they were sufficiently plastic to be pierced with ease by its growing crystals; but as in the formation of schorl from felspar, about two-thirds† of the silica would be set free, we may regard these grains as in part at least formed contemporaneously. But we should have expected to find cryptocrystalline rather

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* *Mineralogical Magazine*, vol. i. p. 215.

† The analyses of tourmaline are very various, the table given in Dana's *Mineralogy*, *s.v.* "Tourmaline," showing percentages of SiO_2 ranging from 35·20 to 42·13, and of Al_2O_3 from 30·44 to 44·4; but taking a black tourmaline from Bovey as an example (which seems a fairly normal one), we have $SiO_2 = 37·00$, and $Al_2O_3 = 33·09$; and assuming for orthoclase the normal analyses given by Dana, $SiO_2 = 64·6$, $Al_2O_3 = 18·5$, we find that the alumina from this, if used in forming tourmaline, will require about 20·8 of SiO_2 leaving free 43·9, which accounts for the considerable patch of quartz in which the needles of schorl are embedded.

than crystalline grains of quartz. Still, the general absence of the cavities, so usual in the quartzes of granite, favours the view of a secondary origin. But in that case what has the fluor replaced? It is certainly no accidental constituent; for it constitutes about one-fifth or one-sixth of the whole mass, which is about the proportion of the quartz in a normal granite.* This question is most likely to be answered by examining the unaltered rock of the district.

Mr. Worth has kindly forwarded to me a good specimen of the normal Trowlesworthy granite. It consists of reddish felspar, greyish quartz, and a very moderate amount of a black mineral, which is partly black mica, partly tourmaline. In coarseness of grain and the proportion of the felspar, it agrees fairly well with the other specimen, the latter mineral being rather more abundant than in the Trowlesworthite, although it is not quite so conspicuous at first sight, as the contrast of colour is less marked than when it occurs with the dull green acicular tourmaline and the purple fluor spar. On examining the rock microscopically, I find it to consist of felspar, quartz, mica, and tourmaline. The felspar is rather decomposed and ferrite stained—orthoclase, and a plagioclase, either albite or oligoclase, may however be recognised. There is nothing in its nature or appearance to call for any special remark.

* From rough calculations which I have de, the felspar in a normal granite is from 75 to] cent. of w quartz from 15 to 20 per cent., and

The quartz has consolidated subsequently to the felspar; it is in moderate-sized granules of not very regular outline, frequently associated in twos or threes. It is very full of enclosures, so as to bear a conspicuously "dirty" aspect when viewed with a low power objective Examined with higher powers—from a quarter to an eighth inch—the majority of these enclosures appear to be cavities, some empty and apparently darkened by a mineral coating; others clear and containing fluid. They vary greatly in form and size. Some are very irregular in outline; others regular and spheroidal. Perhaps a not unfrequent diameter is about ·001 inch, but they are occasionally greater and frequently less. Bubbles are very frequent, but the ratio of the volume of the bubble to that of the whole cavity varies considerably; say from about 1:12 to 1:6. There is one fair-sized crystal of biotite or lepidomelane rather altered; and two or three smaller grains, still more changed, between two of which occurs an irregular-shaped granule of tourmaline (brownish), enclosing and associated with patches of a rather fibrous micaceous mineral, giving bright colours with the crossed nicols, and extinguishing parallel with its fibres—a decomposition product from mica or felspar. The acicular greenish tourmaline (schorl) is conspicuous by its rarity, if not entirely absent.

The result, then, of the examination of this specimen has been to confirm the view which I formed on studying the Trowlesworthite, viz., that the latter has been formed from the normal

granite of the district by the following mineral changes:

(1) Replacement of the mica by brownish tourmaline.

(2) Replacement of some portion of the felspar by acicular greenish-black tourmaline (schorl) and quartz.

(3) Replacement of the original quartz by fluor spar.

I need hardly say that I am fully conscious of the chemical difficulties involved in the last supposition. Replacement of fluor by quartz is familiar enough; but of the converse operation I am not aware that any instance is on record, and it is not easy to see how it would be effected consistently with the other changes in the rock. At present I will not attempt to offer an explanation, but will simply recapitulate the reasons which have led me to this conclusion.

(1) The general correspondence of the two rocks, fluor spar occurring in the Trowlesworthite in the same way as quartz occurs in the normal granite.

(2) The schorl in the Trowlesworthite indicates by its mode of occurrence that it has been derived from the destruction of some of the felspar, in which case a considerable amount of silica would be set free, which might crystallize as quartz.

(3) The quartz in the normal granite is very full of cavities and enclosures. The quartz in the Trowlesworthite is singularly clear; it is pierced, like a pincushion, with needles of schorl, and now and then contains a speck of ferrite, or a cavity with

a bubble; but of the latter there is not one where there would be a dozen in the granite. Only one small grain of quartz in the Trowlesworthite resembles that in the granite, *and this is free from schorl.*

These considerations leave to my mind no escape from the conclusion as to the history of the rock Trowlesworthite, which I have mentioned above. Remembering the proverb, *Ne sutor ultra*, I will not attempt the solution of the chemical problem, but will propound it for the consideration of those who have made that branch of Natural Science their special study.

ON THE ANCIENT METALLURGY OF CORNWALL.

A PAPER was read by Mr. Alfred Tylor, F.G.S., "On the Ancient Metallurgy of Cornwall."

The geological conclusions of the writer were summed up as follows: So far as I am able to judge, there seems to be more than an accidental resemblance between the geological position of the stream tin gravels of Cornwall and the post-tertiary or quarternary beds of the East of England. We have, speaking generally, the following sections in each locality: Cornwall.—(1) surface-soil; (2) peat and buried trees, containing traces of man, over or underlaid with marine clay, and silt marked by the presence of *scrobicularia piperata;* (3) sands and gravels, containing marine shells of more northern character than the present fauna; (4) rough river gravel and sand, the rolled gravel and stream tin deposits in old channels, as at Marazion. East Anglia.—(1) surface-soil; (2) fen, peat, and buried forests, with fen silt of exactly the same character; (3) sands and gravels, with marine shells of somewhat northern character; (4) coarse river gravel and sand; (5) rolled gravel, and possibly Crag in old channels, as at Antwerp and the bays of Suffolk. Now these underlying rough

gravels (No. 4) I have shown to be very much older than the overlying beds, as proved by the following peculiarities: 1. The overlying beds belong to the most recent of geological times, passing into the period of modern beaches. They possess a fauna like that of the present. 2. The underlying beds, on the other hand, belong to an older date, since which great physical changes, in the form of estuaries and of river courses, have occurred, such as at Antwerp and the south coasts of England, and the fauna is not a recent one in the same locality. 4. From the position, as regards the sea level and distribution of the fauna of such beds, and from other data, I believe them to be of glacial or in some cases of pre-glacial age, or of their pluvial equivalents, and deposited in channels opened in the early Crag period.

Royal Geological Society of Cornwall.

THE SEVENTY-FIRST

ANNUAL REPORT

ETC. ETC.

PENZANCE
1885.

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William Hollow (formerly Manager of the Providence Mines), Leyton, Essex.
Benedict Kitto, F.G.S., The Assay Office, George Yard, 36, Upper Thames Street, London, E.C.
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John Rowe, The Terrace, St. Just.
Stephen Thomas.

Names of Honorary Members, Life Members, and Associates whose Addresses are unknown.

John F. Cunningham, F.G.S. | Thomas Hawkins, F.G.S.
Thomas Adair Masey, F.G.S.
Hall, R. T. | Phillips, John.
Thomas, Stephen.

The Secretary requests the favour of his being informed of any inaccuracies in the foregoing lists.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—My distinguished predecessor in this chair has in the two past years conferred a signal service on our Society by reminding us in his addresses of the importance of geological science in directions other than the pursuit of wealth, or the acquisition of material advantage. He has testified to the effect which it has in elevating the mind of man, and has shown us how within a comparatively brief period of years educated people have found it necessary to alter the scope and range of many of their old ideas, and to adopt views and conclusions connected with a greater expansion of thought. More particularly he impressed upon us the entire change which the facts of geology have wrought in the old feeling of the permanence of the outward forms of nature; and he pointed out by reference to some of the recent appalling volcanic phenomena how we are still placed in the midst of a condition of mutation, advancing sometimes by long periods of slow and gentle action, at others by startling outbreaks of catastrophe and destruction.

There is perhaps no part of Europe on which these lessons ought to fall with more telling incidence than on this county of Cornwall. An observer posted here, and extending his gaze to the Bristol Channel and Wales on the one side, and to Brittany on the other, embraces an area of the most attractive and fertile character, not only for the phenomena of the older rock formations, but also for the changes of recent or comparatively modern times.

In several volumes of our *Transactions* contributions of a most valuable character have thrown light on some of these changes which have taken place even within the time of man's dwelling here on earth; and to-day we shall hope that farther information

will bring home more fully to us the evidence of remarkable interchange of sea and land. That evidence, in part, lies within half a dozen miles of these doors, at St. Erth, and was introduced by Mr. Whitley to our meeting two years ago ; bnt it is almost needless to add that the due interpretation of such evidence requires the aid of persons experienced in the art of unravelling somewhat complicated skeins.

The simple outline of the discovery in this neighbourhood is, first, that the shells found in the fine clay associated with sand, which forms a patch of new strata spread on the surface of the killas or old slate rock, north of St. Erth, are of distinctly marine origin. They are comparable to some of the contents of the late Tertiary beds of Suffolk, called the Crag ; and certain of the shells show affinity to those of the sub-Apennine Tertiaries of North Italy. During, then, that period of the world's history which preceded by no very great interval the present order of things, we seem to have had the sea rolling its waves far above the surface of our present low ground, or, more correctly speaking, the land was subjected to so considerable a depression as to have submerged it under a Tertiary (Pliocene) sea. And it depends on those who have made the fauna of the Tertiary groups their special study to tell us in what degree we may link these beds with other analogous formations, and in what manner the alleged affinity with Mediterranean forms may best be explained. Mr. Searles Wood, an acknowledged master in this department of geology, is about to communicate to the Geological Society of London the result of many months' study of the products of the St. Erth vicarage pit, some of which appear to be forms new to science.

It must be admitted that the friend of geological studies in this county suffers somewhat under the disadvantage of so large a portion of the geological record—so vast a series of strata as may be examined in other parts of England—being absent from Cornwall. There is nothing of the comparatively regular and easy stratigraphy of the Secondary strata to be met with till we get beyond Dartmoor to the New Red Sandstone of Torquay, and the Greensand of Haldon Hill. But the members of the society and the studious part of the

public must not forget that we have now in the entrance room so typical a collection of the fossils of the whole series of formations as will enable any industrious person to follow the descriptions of treatises, and even to prepare for taking up practical work in the geological field.

As an aid to study, and to the appreciation of papers read at meetings, I have ventured to present the very distinct table of the strata, prepared by Mr. Jordan, for suspension on your walls. In this are given the generally-employed names of the principal series or groups, with an approximate number to show the thickness in feet, generally taken where the strata are most fully developed.

It must be admitted that this table is, as it were, a first rough sketch, suitable for an outline of the subject of geological history, and that many more subdivisions and special names would need to be added if we desired a particular acquaintance with either one of the divisions.

It needs also to be noticed that beneath the long-debated lands of the Silurian and Cambrian, the domains of Murchison and of Sedgwick, a series of more ancient and even more debatable strata has of late years cropped up. To these, as a somewhat obscure group, generally much metamorphosed, the general name of Archæan has been given; and its divisions and characters will probably require for years farther examination and discussion. We have to remember for the two western counties, in relation to these lower systems, that after all that has been observed, guessed at, and discussed, we are by no means clear about either one of them. The Devonian system, which certain authorities object to leave independent, is not—especially in its palæontology—half understood. The Cambro-Silurian strata, of which in Cornwall we appear to own a considerable area, is in several points very insufficiently defined; and as for the Archæan, it has only been hinted at as probable.

When we cast our eyes over the geological scale, we cannot but feel that there are interesting questions, no less about what we have not got than what we have got, to show in a given certain locality.

What is the meaning of the fact, then, that even if we are now strengthened in Cornwall by a deposit of the veritable "Crag" period, there exists a total blank from that point down to the culm forming the lower division of the Carboniferous? How is it, in other words, that nothing is to be met with here of nearly 30,000 feet thick of strata which have been deposited as sediments in other parts of England? Under what ancient and strange set of circumstances may it have been that none whatever of these various series were ever deposited in this county? Or is it possible that some, or even many of them, may have been deposited at their proper time, and may have afterwards been removed by natural wear and tear, rain, frost, rivers, breakers, and sea currents? We have only to go into the adjoining county to see how the outliers of the Greensand at Haldon Hill, and at Orleigh Court, near Bideford, are distant respectively 20 and 40 miles from the main bulk of that formation at the Black Downs; and it would appear very probable that those many miles of intervening arenaceous deposit have been swept away in the course of ages, leaving only these fragmentary relics to tell the tale of the extensive deposit which once occupied, in the western portion of Devonshire, a part of the sea-bottom stretching away thence to the east of England, and into what is now continental Europe.

There is another reason for referring to the table of the strata. In the course of the history of geology, beginning with the early part of this century, a nomenclature has sprung up, partly English and partly foreign. The names of groups and series of strata have been derived, sometimes from districts, at others from local terms, and occasionally from well-considered scientific reasons. But at last the objections to the present grouping and nomenclature have been considered strong enough to justify the action of committees, consisting of geologists of different countries. It has been thought that the grouping of the minor divisions, as well as the terms by which both principal and subordinate groups are to be known, might be so amended as to pass current for Europe at least, even if it be not feasible to apply them to other quarters of the world. Meetings have been held, and many modifications suggested, at

Bologna and elsewhere, the last in September, at Berlin. But although the harmony has been good enough, it seems doubtful whether this European concert will be more successful than certain other European concerts of late. It is, in fact, likely that, although some of the leading lines may be amended, most countries will prefer to retain some of those subdivisions and appellations which are most descriptive of their own peculiarities of stratification.

This subject of classification and nomenclature has been lately well handled by Mr. W. T. Blanford, F.R.S.;* and a closely related matter of discussion has more recently been brought before the British Association Meeting, at Montreal, by the same geologist, whose biological knowledge, and extensive geological labours in Abyssinia, Persia, and India, entitle him to speak with high authority. His address, as President of the Geological Section, examined the question, How far, in exploring the structure of remote countries, it is correct to conclude that identity, or close similarity, among fossil forms is a proof that the beds containing them are of the same geological age? He referred to the apparent contradictions that had in many instances been introduced where the old idea had been too closely relied upon. No example, perhaps, is more striking than the difficulties which long beset a full view of the truth in the study of the Flora of the coal measures of Australia, the Karoo beds of South Africa, and the Damuda of India, with a great resemblance among themselves and yet a great divergence from any European fossil Flora. The plants, in fact, which prevailed in the coal-bearing strata of Europe, are found to be replaced by totally different forms in Australia, "despite the closest similarity in the marine inhabitants of the two areas at the period." This and other analogous facts justify the faith which geologists have generally reposed in marine evidence; and Mr. Blanford dwells on the importance and interest of the observation, that at the present day the difference between the land faunas of different parts of the world is vastly greater than that of the marine faunas. Hence, if both were

* *Geological Magazine*, July, 1884, p. 318.

found fossilized, it would not be difficult to recognise the marine beds as of like age by their fossil remains; but with the land and fresh-water beds great uncertainty would ensue.

The meeting of the British Association in Canada appears naturally to have led to the promulgation and discussion of broad views in many of the sections; and attention was drawn in a notable degree to some of the great features of the Natural History of the North American continent. It must be well known to those who visit our Library, that surveys have for many years been kept on foot by the Government of the United States, which have issued in a multitude of works of the highest interest, many of them profusely illustrated, and which have been presented with the utmost liberality to societies and individual geologists on this side of the Atlantic. Certain of these surveys, conducted by men of world-wide reputation, have been proceeding simultaneously with the wonderful mineral discoveries of the last thirty-five years; and the unprecedented activity of mining exploration, and its gigantic results, are reflected in the abounding information contained in these volumes.

In many a page of the American descriptions are we reminded of those topics, where mineralogy is more specially allied with geology, to which this Society has ever evinced a not unnatural partiality.

Among the latest and most interesting accounts of the geology of the mining districts of the Pacific slope, I must place very prominently the comparatively brief but masterly descriptive letters, addressed to our foreign member, Privy-Councillor von Dechen, of Bonn, by Professor vom Rath; and for a copy of which I am indebted to the last-named illustrious mineralogist. After passing a twelvemonth in these remarkable States, and prepared as he is by industrious observation in long-continued foreign travel, there is probably no one in Europe whose statements one could hear with more pleasure and confidence.

A first feature of interest is the important part which is taken by granite, in the lofty mountain chains of the Western States, bordered as it is in some districts by sedimentary beds of the

Chalk and the Jura, in others, by the Lower Carboniferous and Silurian. Numerous varieties of what the older observers were wont to consider the fundamental rock, are described by the author; and a favourable opportunity of examining them is afforded by the ascent of Pike's Peak, 14,147 feet above the sea. On this elevated point it will be remembered that the United States Government have established a permanently inhabited meteorological observatory, where the observers, in this loftiest dwelling in the world, had to record their warmest day of last year, the 3rd August, with a temperature of 32 Fahrenheit, or the freezing point; and their coldest, the 16th January, 1884, with a minimum of *minus* 48°.

A very beautiful mineral, in well-developed crystals—the green mikrokline felspar, called amazon-stone—seems to have been discovered by explorers at the time of the "Pike's Peak excitement," or the gold fever of 1864. A single "vug," or crystallized cavity, is said to have produced a ton weight of these fine crystals; and they appear to be associated in places—as at the Topaz-Butte, 9,200 feet high—by those frequent associates of granite, albite, fluor spar, and topaz. Numerous other minerals might be mentioned as enriching this neighbourhood; but the most notable are, perhaps, the phenakite and zircon, described by Messrs. Cross and Hillebrand, in the *American Journal of Science* for 1882, and the kryolite minerals, described by the same authors in that journal for October, 1883. If, however, Herr vom Rath, with his practised eye, travelling up from Manitou, a height of 7,850 feet to the top, was "unable to find a trace of the amazon-stone," or even to see "a single crystal-lined cavity or vein," what shall we say of the small chances of the thousands of tourists who are expected shortly to rush up and down Pike's Peak, by a railway which is already commenced?

Of all the districts visited and examined by this experienced traveller, the most surprising, in its natural characters and in the history of its rise and fall, is the territory of Nevada, raised in the days of its prosperity to the dignity of a state. Its great mining centre, Virginia City, five or six years ago one of the richest towns

on the face of the earth, where the precious metals seemed to have no value, has sunk deeply, and in its fall has dragged down the whole district, and especially Carson City, the capital. "Thus," continues vom Rath, "does Nevada teach us most distinctly, that it is agriculture alone that forms the enduring foundation of a state. Utah and Nevada possess very similar physical properties, yet how different is the picture that they present!" In Utah cultivation is continually extending, and the victorious combat of man against the naturally desert character of the country is one of the most remarkable and gladdening spectacles. In Nevada a similar beginning was made, when it was known as West Utah, till the progress of mineral dicovery caused the recall of the industrious cultivators, and the invasion of a very different class from California. Then, within 15 years, there were produced from a single lode (the Comstock), the unprecedented amounts of gold and silver estimated at the value of 315 millions of dollars (in round numbers some £63,000,000), of which 175 millions of dollars were from silver, and the remainder gold. Amid the difficulties of great depth and excessively high temperature, the workings have been pressed forward with a rapidity unknown in the Old World, "and yet," says an official paper, "with all the wealth extracted from our mines, the people of Nevada to-day are poor. Not a dollar of the net profit of our mines is invested in the State."

Towns and settlements which ten years ago were prospering, in Stoney, Washoe, and Ormsby Co., are now mostly deserted, and the population of the State has shrunk to some 40,000, whilst people are still leaving for the North and North-West. Yet it would seem, from apparently good testimony, that Nevada might have been thoroughly peopled and cultivated, had the same provident care for the future and the same organisation been employed which have changed the wilderness of Utah into a paradise. The story of the development of the Nevada mining district is the more important because of the suddenness of its downfall.

Virginia City was erected along the back of the Comstock lode at an elevation of more than 6,000 feet above the sea-level, and after being extended, along with Goldhill, to a length of above two

miles, is already but a shadow of its former self, with a population dwindled down from 20,000 to 4,000, with its great bunches of ore (*bonanzas*) worked out, and no new ones apparently discovered to take their place.

Herr vom Rath has given us his impressions of an underground inspection of one of the most famous of the mines, the Consolidated Virginia, which, from a length of only 711 feet on the run of the lode, produced, in six years, 1873 to 1878, over twelve millions of pounds worth of gold and silver, giving profits of over eight millions of pounds. *

This marvellous mine has been sunk to the depth of 3,100 English feet, or 516 fathoms, and yet, after a considerable amount of ground had been opened in the deep levels, it is reported that at the time of the inspection not a trace of ore was to be seen, whilst the "Yellow Jacket," a neighbouring mine, and formerly one of the richest, had been abandoned to the waters. At these great depths it is a well-known fact that the temperature in descending has been found to increase in a ratio far more rapid than is known elsewhere. With all the contrivances employed for cooling the working places by a powerful ventilation, the temperature has only been brought down to between 114 and 117 F., so that the men have worked for a spell of only twenty minutes at a time, and then have retired to a chamber cooled with ice, where they could enjoy the comparatively fresh air of 86 F. Thus, in a core of eight hours, they could devote only two hours and forty minutes to work, and had five hours and twenty minutes for cooling and rest. All this will remind the Cornish miner of the facts noted twenty and thirty

* The values of the amounts of gold and silver raised were as follows, in dollars:

Year.	Gold.		Silver.		Total.	
1873	314,289	Dols.	331,293	Dols.	645,582	Dols.
1874	2,063,438	,,	2,918,046	,,	4,981,484	,,
1875	7,035,206	,,	9,682,188	,,	16,717,395	,,
1876	7,378,145	,,	9,279,504	,,	16,657,649	,,
1877	6,270,519	,,	7,463,500	,,	13,734,019	,,
1878	3,770,008	,,	4,226,745	,,	7,996,753	,,
		,,		,,		,,
	26,831,605	,,	33,001,316	,,	60,732,921	,,

The profits on the above amounted to 41,040,000 dollars.

years ago in the Clifford Amalgamated, formerly the United, Mines in Gwennap; but in the Nevada mine we have on each point an exaggeration of the older case, the depth, the heat, and the difficulties of working; and it would seem that we had, in the Comstock, nearly attained to the limits at which it is possible to continue operations.

It appears in this instance of abnormally high temperature that this phenomenon, difficult as it may be to account for, is distinctly connected with the lode itself, and not with the depth and country rock alone. Careful thermometrical observations were made during the driving of the deep adit level called the Sutro Tunnel, which brings in a depth of 1,865 feet under the highest points of the outcrop, and it resulted that the excessive temperature only began to be felt on approaching the gigantic lode.

Very full details of these experiences have been given by Mr. George F. Becker, in his valuable work entitled *Geology of the Comstock Lode and the Washoe District*, 1882. But whilst referring you for more complete information to that treatise and the official reports, I trust that even an outline of the facts may convey a useful lesson; since among the various difficulties which shorten the lives of mining enterprises, there is no doubt that improvidence, and too hurried a grasping at making the most of the present, are faults not unknown in other districts besides Nevada.

Before proceeding to the business of the meeting, I have to record with sorrow the loss sustained by the Society in the decease of two very old members, Mr. Brittain, and Mr. Richard Davey, for some years one of the representatives in Parliament of the western division of the county. Mr. Davey, along with his elder brother, Mr. Stephen Davey, of Redruth, early imbibed a taste for mineralogy, which, connected as he was with numerous mining adventures, he retained till late in life. We have also to mourn the untimely death of Mrs. J. M. Williams, of Carhayes Castle, the niece of Mr. R. Davey, whose accomplishments and interest in the fine mineral collection of Carhayes will not soon be forgotten by those who had the pleasure of her acquaintance.

REPORT OF THE COUNCIL.

At the close of another year it again becomes incumbent upon the Council to render an account of the proceedings of the Society; and in presenting their Seventy-first Annual Report once more to congratulate the members upon its flourishing condition.

In the Library the arrangement of the books has been continued, and but few volumes now remain to be bound. Many donations have been received, as you will learn more particularly from the report of the Librarian.

To your Museum numerous and valuable additions have been made, and many of your unarranged treasures—the donations of recent years—have lately been labelled, and displayed in the table cases, and entered in the catalogue. For the carrying out of this work the thanks of the Society are due to Mr. Solly, demonstrator to the Professor of Mineralogy at Cambridge.

In consequence of the removal from the county of Mr. Frecheville, we shall be deprived of much of his valuable assistance. The Council therefore beg to suggest that Dr. Carne Ross be associated with him as co-Curator.

During the past year Classes have been conducted in the Class-rooms and Laboratory of the Museum by Mr. A. K. Barnett, F.G.S., and Mr. E. C. Corin. The subjects taught were Theoretical and Practical Chemistry, Mineralogy, and the Principles of Agriculture.

At the May examinations of the Science and Art Department many of the Students distinguished themselves, especially in Practical Chemistry, showing careful training in simple and complex analysis.

The Laboratory is at present well stocked, and affords facilities for a complete study of analytical chemistry.

This year classes have been arranged in the same subjects as were taught last year, and Geology has been added to the list.

It is with much regret that your Council have to record that since the last Annual Meeting three members have been removed from our roll by death. Mr. Richard Davey, who died at Bochym on the 24th June, 1884, has for very many years been a member of the Society. Mr. Brittain also, who died early in the year, has been one of its supporters from the time of his taking up his residence in Penzance. And in May last died Mrs. Williams, of Carhayes Castle, a lady of remarkable ability.

In conclusion the Council desire to recommend the election of Mr. W. S. Bennett, of Penzance, and of Mr. W. E. Baily, of Lynwood, Paul, as ordinary members of the Society.

GEORGE BOWN MILLETT,
Honorary Secretary.

NOVEMBER 4th, 1884.

LIBRARIAN'S REPORT.

THE following works have been added to the Library:

I. TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies, Editors, and other Donors, or purchased.

Anglesey, Brecon, &c. Dr. C. Le Neve Foster's Report upon the Inspection of Mines classed under the Metalliferous Mines Regulation Acts in the Counties of Anglesey, Brecon, Cardigan, Carnarvon, Denbigh, Flint, Merioneth, Montgomery, Radnor, and Shropshire, and in the Isle of Man, for the year 1883. Folio. [London] 1884.

Boston. American Academy of Arts and Sciences.
Proceedings: Vol. x., May, 1882, to May, 1883.
„ Vol xi., parts 1, 2, May, 1883, to May, 1884.
8vo. Boston, 1883–84.

Bristol. Bristol Naturalists' Society. Annual Report, and List of Council, Officers, Members, &c., 1884. Proceedings: (New Series) vol. iv., part 2, 1883–84. 8vo. Bristol, 1884.

Brussels. Société Royale Malacologique de Belgique. Procès-Verbal. April, 1882, to July, 1883. 8vo. Bruxelles, N.D.

Cambridge. University Library: Thirtieth Annual Report of the Library Syndicate to the Senate, June 4th, 1884. Folio. N.P., 1884.

Canada. Geological and Natural History Survey of Canada. Catalogue of Canadian Plants. Part i., Polypetalæ. By John Macoun. Report of Progress for 1880–81–82. By A. R. C. Selwyn, Director. With accompanying Maps. 8vo., Montreal, 1883.

Canada. Royal Society of Canada. Proceedings and Transactions for the years 1882 and 1883, vol. i. 4to. Montreal, 1884.

Christiania. Presented by the Royal University of Norway: Et Stykke Geografi i Norge. Af Prof. Th. Kjerulf. 8vo. N.P. N.D.

——. En Hule paa Gaarden Njφs, Leganger Præstegjæld i Bergens Stift. Af Hans H. Reusch. 8vo. Christiania, 1874.

——. Om Norvegium, et nyt Tungt Metal. Af Dr. Tellef Dahll. 8vo. Christiania, 1879.

——. Nogle bemærkninger om Granit. Af J. H. L. Vogt. 8vo. Christiania, 1881.

——. Fortsatte bemærkninger om Reliefforholde. Af Prof. Dr. Th. Kjerulf. 8vo. Christiania, 1881.

——. Die Silurischen Etagen 2 und 3 im Kristianiagebiet und auf Eker. Von W. C. Brφgger. 8vo. Christiania, 1882.

——. Silurfossiler og Pressede Konglomerater i Bergensskifrene. Af Hans H. Reusch. 8vo. Christiania, 1882.

——. Fortegnelse over den Tilvæxt, som det Kgl. Frederiks Universitets Bibliothek har erholdt i Aarene, 1880–81. 8vo. Christiania, 1883.

——. Nye Oplysninger om Olivinstenen i Almeklovdalen og Sundalen paa Sφndmφre. Af H. H. Reusch. 8vo. Christiania, 1883.

Dorpat. Dorpater Naturforscher-Gesellschaft. Archiv für die Naturkunde Liv-, Ehst- und Kurlands:

I. Serie. Band ix. Heft 1, 2. 8vo. Dorpat, 1882.
II. „ „ ix. Heft 1–5. 8vo. „ 1880–84.
Sitzungsberichte: Band vi. Heft 1, 2, 3. 8vo. Dorpat, 1882–84.

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„ „ xx., „ 1, 2. 8vo. „ 1883.

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Duncan and Sladen: Fossil Echinoidea from the Khirthar series of Nummulitic Strata in Western Sind. [Series xiv. Vol. i., part 3, fasc. 3.]

Duncan and Sladen: Fossil Echinoidea of Kachh and Kattywar. (Introduction by Blanford.) [Series xiv. Vol. i., part 4.]

Feistmantel; Fossil Flora of the South Rewah Gondwána Basin. [Series xii. Vol. iv., part 1.]

Lydekker: Siwalik Camelopardalidæ. [Series x. Vol. ii., part 4.]

„ Siwalik and Narbada Carnivora. [Series x. Vol. ii., part 6.]

„ Additional Siwalik Perissodactyla and Proboscidia. [Series x. Vol. iii., part 1.]

„ Siwalik and Narbada Bunodont Suina. [Series x. Vol. iii., part 2.]

„ Rodents and New Ruminants from the Siwaliks, and Synopsis of Mammalia. [Series x. Vol. iii., part 3.]

„ Siwalik Birds. [Series x. Vol. iii., part 4.]

India. Waagen: Productus Limestone Fossils — Brachiopoda. [Series xiii. Vol. i., part 4, fasc. 1, 2.] 4to. Calcutta—London, 1882–84.

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„ „ xvi.
„ „ xvii., parts 1–3.
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4to. Tokio, 2543 Japanese Era. [= A.D. 1883.]

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Deel XLII. (Achtste serie, deel III.)
8vo. Batavia's Gravenhage, 1883.

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New Series, vol. viii., part 2, 1883.
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„ „ II., June, 1838, to June, 1841.
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„ „ IV., June, 1845, to June, 1850.
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„ „ IX., June, 1870, to June, 1879.
8vo. Leicester, 1876–84.

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„ xxxvi. 1881–82.
„ xxxvii. 1882–83.
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[Two foregoing presented by Mr. J. L. Clare.]

——. Liverpool Geological Association. Annual Report for 1883. 8vo. N.P., N.D.

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8vo. Liverpool, 1882–83.

London. British Association for the Advancement of Science. Report of the Fifty-third Meeting, held at Southport, in September, 1883. 8vo. London, 1884.

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Proceedings: Title-page, contents, and index of vol. vii.

„ Nos. 2–6 of vol. viii.

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[The three foregoing presented by Mr. R. J. Frecheville.]

——. London, Edinburgh, and Dublin Philosophical Magazine: Series V. Nos. 101–102 of vol. xvi.
„ Nos. 103–109 of vol. xvii.
„ Nos. 110–114 of vol. xviii.
8vo. London, 1883–84. *Purchased.*

——. Palæontographical Society's volume for 1883. 4to. London, 1883. *Purchased.*

——. Royal Society. Proceedings:
No. 227 of vol. xxxv.
„ 228–231 of vol. xxxvi.
„ 232 of vol. xxxvii.
8vo. London, 1884.

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„ Vol. iii. Nos. 1–9. 8vo. „ „ 1884.
Bye-Laws. 8vo. „ „ 1884.

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Proceedings: Part 4, vol. i. 8vo. London, 1883.
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[From His Excellency the Minister for the Colonies, at the Hague.]

Newcastle-upon-Tyne. Newcastle-upon-Tyne Chemical Society. Transactions: Parts 1–4 of vol. v. 8vo. [Newcastle-upon-Tyne] 1880–81.

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Série viii., t. iii., liv. 3. 8vo. Paris, 1883.
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8vo. Philadelphia, 1883–84.

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Pisa. Società Toscana di Scienze Naturali.

Processi Verbali: pp. 273–290 of vol. iii., pp. 1–124 of vol. iv., title-pages for vols. i. and iii., and indices for vols. i. ii. iii.

Memorie: Vol. vi., fasc. 1°. 8vo. Pisa, 1883–84.

Plymouth. Plymouth Institution and Devon and Cornwall Natural History Society. Annual Reports and Transactions for the years 1882–83, and 1883–84, parts 2, 3, of vol. viii.

8vo. Plymouth, 1883–84.

Sacramento. California State Mining Bureau. Third Annual Report of the State Mineralogist for the year ending June 1st, 1883. [Includes "Report on the Borax Deposits of California and Nevada," by Henry G. Hanks, State Mineralogist.]

8vo. Sacramento, 1883.

Salford. The First Charter of Salford, County Lancaster. By J. E. Bailey. Reprinted, with additions, &c., from "The Palatine Note-Book" for July and August, 1882.

8vo. Manchester, 1882.

[Not published.]

——. Corporation of Salford. Royal Free Museum and Library, Peel Park. Descriptive Catalogue of Pictures, Portraits, and Sculpture in the Art Galleries and Museum. The Permanent Collection. By John Plant, curator. Revised August, 1883.

8vo. Salford, N.D.

——. Thirty-fourth and Thirty-fifth Annual Reports of the Museum, Libraries, and Parks Committee for the Borough of Salford. 1881–82, 1882–83. 8vo. Salford, N D.

Truro. Miners' Association of Cornwall and Devon.

Reports and Proceedings for the year 1883.

8vo. Truro, 1884.

——. Mining Institute of Cornwall.

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8vo. Plymouth—Truro, 1880–84.

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8vo. Truro, 1884.

United States. Geological and Geographical Survey of the States. Bulletin: No. 1, On Hypersthene-Andesite, and on Triclinic Pyroxene in Augitic Rocks. By Whitman Cross. With a Geological Sketch of Buffalo Peaks, Colorado, by S. F. Emmons. 8vo. Washington, 1883.

——. Geology of Wisconsin. Survey of 1873–79.

Vol. I. General Geology. Natural History. Industrial Resources. 8vo. Madison, 1883.

Vol. IV. Upper Mississippi Region. Lower St. Croix Region. Description of Fossils. Ore Deposits of S.W. Wisconsin. Quartzite of Barron and Chippewa Counties. Flambeau Region. Crystalline Rocks of Wisconsin Valley. Superficial Geology of Upper Wisconsin Valley. Character and Methods of the Geodetic Survey. 8vo. Madison, 1882. Accompanied by Atlas of Maps.

——. Monographs: II. Tertiary History of the Grand Cañon District. By Clarence E. Dutton. Accompanied by Atlas. 4to. Washington, 1882.

——. Second Annual Report of the . . . Survey to the Secretary of the Interior, 1880–81. By J. W. Powell, Director. 8vo. Washington, 1882.

——. Survey of . . . Wyoming and Idaho, 1878. Twelfth Annual Report of Progress of the Exploration. By F. V. Hayden.

Part I. Geology; Palæontology; Zoology.

„ II. Geology; Thermal Springs; Topography.

With Atlas of Maps and Panoramas.

8vo. Washington, 1883.

Victoria. Geological Survey of Victoria. Report of Progress [No. vii.] by the Secretary for Mines, with Reports on Geology, Mineralogy, Mining, and the Physical Structure of various parts of the Colony, by R. A. F. Murray, J. C. Newbery, F. McCoy, A. J. Agg, A. W. Howitt, and J. Sterling. 8vo. Melbourne, 1884.

——. Report of the Chief Inspector of Mines to the Honourable the Minister of Mines for the year 1883. Folio. Melbourne, 1884.

Victoria. Reports of the Mining Surveyors and Registrars of Victoria for the Quarters ended 30th June, 30th September, and 31st December, 1883; and 31st March, and 30th June, 1884. Folio. Melbourne, 1883–84.

Vienna. K. K. Geologische Reichsanstalt:
Verhandlungen. Nos. 10–18, and title-page, 1883.
„ Nos. 1–14, 1884.
8vo. Wien. 1883–84.

Washington. Congressional Directory, compiled for the Use of Congress. By Ben. Perley Poore, Clerk of Printing Records. First edition. Corrected to December 11, 1882. 8vo. Washington, 1882.

——. Smithsonian Institution. Annual Reports of the Board of Regents for the years 1881–82. 8vo. Washington, 1883–84.

II. GEOLOGICAL AND MISCELLANEOUS PUBLICATIONS.

Presented by the Authors or Purchased.

Bramall, Henry. The Mineral Resources of New Zealand. With map of Gold and Coal Fields. 8vo. Liverpool, 1883.

—— Modern Progress in Mine Engineering. 8vo. Liverpool, 1884.

Collins, Joseph Henry. On the Serpentine and Associated Rocks of Porthalla Cove [Cornwall]. [From Quar. Journ. of Geol. Soc., August 1884.] 8vo. London, 1884.

Geinitz, H. B. Ueber neue Funde in den Phosphatlagern von Helmstedt, Büddenstedt und Schleweke. Mittheilung aus dem Kgl. Mineralogischen Museum. [From Ges. Isis in Dresden, 1883.—abh. 5.] 8vo. Dresden.

——. Nachträge zu den Funden in den Phosphatlagern von Helmstedt, Büddenstedt u.a. 8vo. Dresden, 1883.

Hunt, Robert. British Mining: a Treatise on the History, Discovery, Practical Development, and Future Prospects of Metalliferous Mines in the United Kingdom. Purchased. 8vo. London, 1884.

Jordan, Jas. B. Table of British Strata. [Large coloured diagram, varnished and mounted on canvas and roller.] London, May, 1884.

[Presented by the President, Mr. W. W. Smyth, F.R.S.]

Menke, Carolo Theodoro. Synopsis Methodica Molluscorum. Editio altera, auctior et emendatior. 8vo. Pyrmonti, 1830.

[Presented by Mr. Fortescue Millett.]

Peacock, R. A. Saturated Steam the Motive Power in Volcanoes and Earthquakes; great importance of Electricity.

——. Second Edition, improved. 8vo. London, 1882.

Pengelly, William. On a Flint Implement found on Torre Abbey Sands, Torbay, in 1883.

——. Discoveries in the more Recent Deposits of the Bovey Basin, Devon.

——. Notes on Notices of the Geology and Palæontology of Devonshire. Part X.

[Reprints from Transactions of Devonshire Association for the Advancement of Science, Literature, and Art, 1883. XV., pp. 137–140, 368–395, 476–486. Read at Exmouth, August, 1883.]

Stache, Guido. Fragmente einer Afrikanischen Kohlenkalk fauna aus dem Gebiete der West-Sahara. Bericht über die untersuchung der von Dr. Oskar Lenz auf der Reise von Marokko nach Timbuktu Gesammelten Paläozoischen Gesteine und Fossilreste. 4to. Wien, 1883.

[Presented by Mr. Fortescue Millett.]

Symons, Brenton. The Maidanpec Wet Process for the Reduction of certain Poor Cupreous Ores. [From Proceedings of Mining Institution of Cornwall, 1883.] 8vo. Truro, 1884.

TREASURER'S STATEMENT, 1883-84.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

November, 1884.	£	s.	d.
To Balance	61	4	11
„ Donation from H.R.H. the Prince of Wales	20	0	0
„ Acknowledgement of Lights, per Public Buildings Company	0	2	0
„ Ordinary Subscriptions and Arrears	72	9	0
	£153	15	11
„ Balance	36	7	7

November, 1884.	£	s.	d.
By Rates and Taxes	0	8	0
„ Housekeeper	9	15	0
„ Assistant Curator and Donation	30	5	0
„ Insurance	2	12	9
„ Palæontographical Society	1	1	0
„ Donation to Science Classes	5	0	0
„ Printing, Books, and Stationery	45	1	8
„ Sundry Bills	8	4	11
„ Expenses, per Secretary and Treasurer	15	0	0
„ Balance forward	36	7	7
	£153	15	11

4th November, 1884.

W. BOLITHO, JUN.,
Treasurer.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

4th November, 1884.

1. On the Occurrence of Volcanic Tuffs, Breccia, &c., in the Meneage District. By Alexander Somervail and Howard Fox.

2. The Raised Beaches on Plymouth Hoe. By R. N. Worth, F.G.S.

3. Notes on the Fossil Foraminifera of the St. Erth Clay Pits. By Fortescue William Millett.

4. The Umber Deposits at Ashburton. By R. J. Frecheville, F.G.S., one of H.M.'s Inspectors of Mines.

5. Note to accompany a Specimen of Native Gold from Leadville, Colorado. By C. Le Neve Foster, D.Sc.

Pisa. Società Toscana di Scienze Naturali.

Processi Verbali: pp. 273–290 of vol. iii., pp. 1–124 of vol. iv., title-pages for vols. i. and iii., and indices for vols. i. ii. iii.

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United States. Geological and Geographical Survey of the States. Bulletin: No. 1, On Hypersthene-Andesite, and on Triclinic Pyroxene in Augitic Rocks. By Whitman Cross. With a Geological Sketch of Buffalo Peaks, Colorado, by S. F. Emmons. 8vo. Washington, 1883.

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[Presented by Mr. Fortescue Millett.]

Symons, Brenton. The Maidanpec Wet Process for the Reduction of certain Poor Cupreous Ores. [From Proceedings of Mining Institution of Cornwall, 1883.] 8vo. Truro, 1884.

CURATOR'S REPORT.

THE following specimens have been added to the Museum during the year.

Presented by Mr. H. B. Nicholas, Senior Inspector of Mines, Castlemaine, Victoria:

1-7. Moulded, planed, and cleaved Slates. Harcourt Slate Quarries, near Mount Alexander, Castlemaine District.

8. Schorlyte Nodule in Granite. Blight's Quarries, Mount Alexander, Castlemaine District.

9,10. Granite containing Chalcopyrite and Molybdenite. Blight's Quarries, Mount Alexander, Castlemaine District.

11. Schorlyte Nodule investing angular fragment of Quartz, in Granite. Blight's Quarries, Mount Alexander, Castlemaine District.

12. Granite. Cube; one face polished. Blight's Quarries, Mount Alexander, Castlemaine District.

13. Granite. Cube; one face polished. Blight's Quarries, Mount Alexander, Castlemaine District.

14. Granite. Cylinder; polished. Blight's Quarries, Mount Alexander, Castlemaine District.

15. Slate, with layer of Quartz and Auriferous Pyrites on vertical edges. Rowe Bros'. Mine, Fryer's Creek, Castlemaine District.

16. Auriferous Quartz. Rowe Bros'. Mine, Fryer's Creek, Castlemaine District.

17-24. Auriferous Quartz. Mount Tarrengower Mines, Castlemaine District.

25-29. Auriferous Quartz. Bristol Hill, Telegraph, and Union Mines, Maryborough and Amherst Districts.

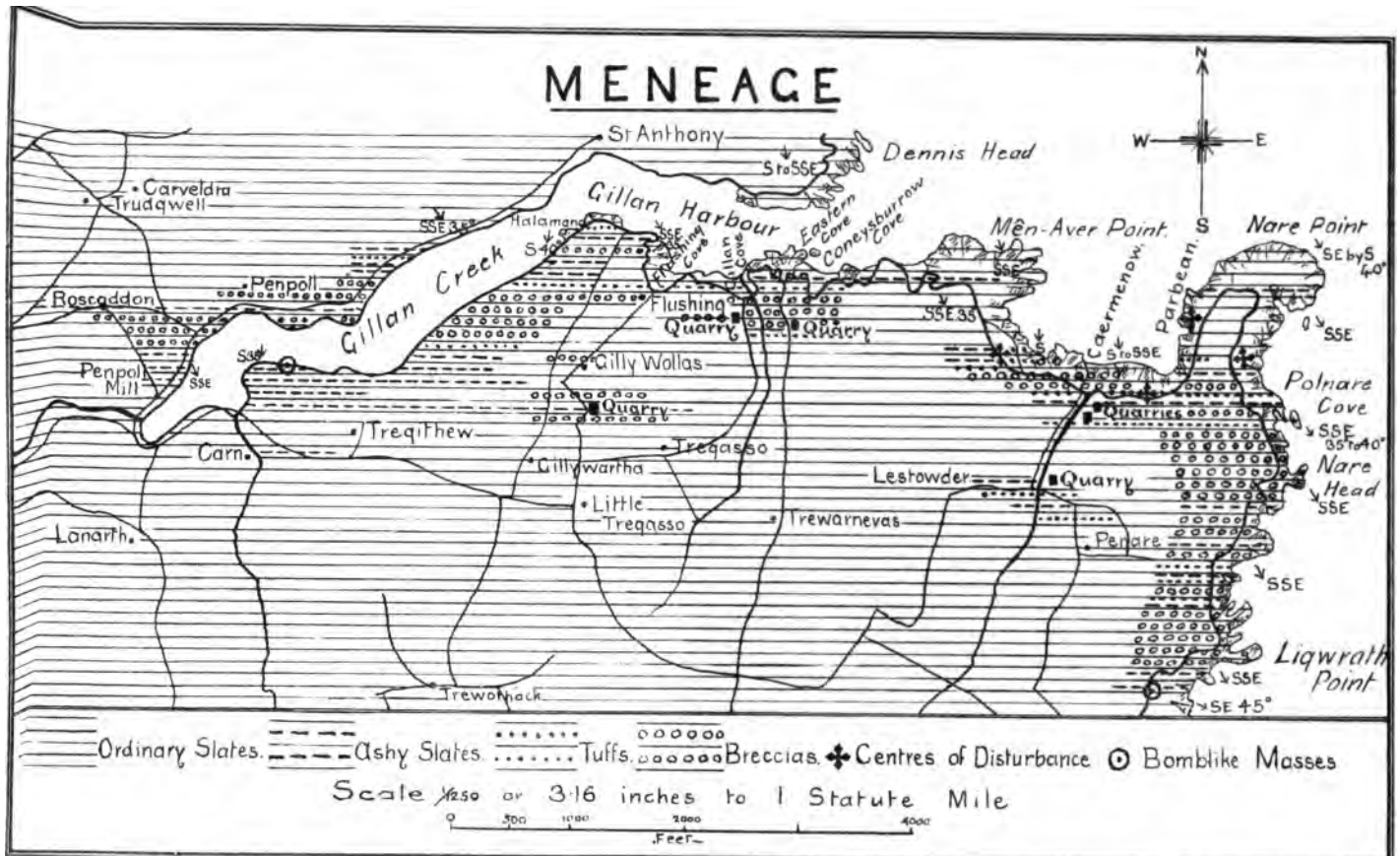
30, 31. Stream Tin. Kœtong, Upper Murray District.

32. "Gabbro." Cut and polished. Found in large boulders at 200 feet deep in the Alluvial Drift at the Homebush "lead," Avoca. The bed-rock is Granite.

33. Slab of Lower Silurian Slate, containing Graptolites. Rowe Bros'. Mine, Fryer's Creek.

34. Piece of indurated Sandstone intersected by Quartz Veins, illustrating in miniature the effects of "caunters" and cross-courses.
35. Portions of Core from a horizontal bore-hole of 500 feet long, made by a diamond drill instead of driving a cross-cut.
36. Jar containing Crude Arsenic. Castlemaine Pyrites Works.
37. Jar containing Sesquioxide of Iron. Castlemaine Pyrites Works.

	NAME AND LOCALITY.	DONOR.
38.	Sandstone (? sub-carboniferous) showing markings of Calamites and other vegetable remains, and containing spangles and thin plates of native Silver. The Sandstone is valued at 2500 to 3000 dollars per ton for the contained Silver. Silver Reef, about 300 miles south of Salt Lake City, Utah, U.S.A. . .	Thomas Stevens, of St. Just, per T. Cornish.
39.	Galena, Iridescent. Foxdale Mines, Isle of Man	W. W. Smyth.
40.	Native Gold. Lilian Mine, Leadville, Colorado	C. Le Neve Foster.
41.	Rich Argentiferous Lead Ore. Lilian Mine, Leadville, Colorado. . .	"
42.	Slate scratched by glacial action. Bwlch-y-haiarn, Llanrwst, N. Wales . .	"
43–46.	Specimens to illustrate Mr. R. J. Frecheville's paper on the Ashburton Umber Deposit	R. J. Frecheville.
47–48.	Two Slides of Foraminifera [Rotalia punctato-granosa, *Sequenza;* and Faujasina ——?]. St. Erth Clay . . .	Fortescue Millett.
49–52.	Four rock specimens to illustrate Mr. T. Cornish's remarks on a new locality for Trowlesworthite, at St. Just . .	Mr. Leathan, per T. Cornish.
53.	Fossil Shells from St. Erth Clay . .	T. Cornish.
54.	Apatite. (Large crystal, of peculiar colour, and showing strong signs of cleavage.) From Renfrew, Canada . . .	R. H. Solly.


MENEAGE
N
W
E
S
St Anthony
Dennis Head
S to SSE
Carveldra
Trudgwell
Gillan Harbour
Halamanda
SSE 35°
S 40°
Gillan Creek
Flushing Cove
Gillan Cove
Eastern Cove
Coneysburrow Cove
Mên-Aver Point
Nare Point
SE by S 40°
Caermenow
Parbean
Penpoll
Roscaddon
Flushing
Quarry
SSE 35
S to SSE
SSE
Penpoll Mill
Gilly Wollas
Quarry
Quarries
Polnare Cove
SSE 35° to 40°
Nare Head
Tregithew
Carn
Tregasso
Gillywartha
Lestowder
Quarry
Little Tregasso
Trewarnevas
Lanarth
Penare
Liqwrath Point
SE 45°
Trewothack
Ordinary Slates.
Ashy Slates.
Tuffs.
Breccias.
Centres of Disturbance
Bomblike Masses
Scale 1/1250 or 3·16 inches to 1 Statute Mile
0
500
1000
2000
4000
Feet

ON THE

OCCURRENCE OF VOLCANIC TUFFS, BRECCIA, &c., IN THE MENEAGE DISTRICT.

By Alexander Somervail and Howard Fox.

The object of this paper is to give a brief description of certain beds of fragmentary rocks occurring in the Meneage district. These rocks have hitherto been generally described as ordinary "conglomerates." We believe them to be of igneous origin, and to consist of tuffs, breccias, and other similar products, formed contemporaneously with the strata, among which they occur as interbedded deposits.

The accompanying map has been reduced from the 25-inch Ordnance parish maps, and the names of the various Points and Coves are mostly taken from the same source. The parallel lines indicate approximately the strike of the beds.

These so-called "conglomerates" have been described by several able observers. Professor Sedgwick* notices the beds as being "strictly conformable with the mineral masses in the neighbourhood," and does not appear to doubt their aqueous origin. Dr.

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* *Trans. Cambridge Phil. Soc.* vol. i. p. 295.

Boase* writes to the same effect. Sir H. de la Beche,† in describing the coast sections, makes no allusion to other than an aqueous origin of these "conglomerates," although in a subsequent chapter‡ he suggests their possible igneous origin. The Rev. E. Budge § described these beds in considerable detail, adopting De la Beche's views. Mr. J. H. Collins|| regards these "conglomerates" as a series of aqueous deposits, and breaks them into two distinct geological formations unconformable with each other. Professor Bonney¶ speaks with some degree of caution regarding one of the beds, which he thought at first sight might be an agglomerate.

Boundary and Relations to Adjoining Strata.—The exact boundary of these "conglomerates" is between the north shore of Gillan Creek, about half a mile west of St. Anthony Church, and a point a short distance south of Ligwrath Point. The slates and the included "conglomerates" have a south and south-easterly dip, the latter prevailing from St. Anthony southwards. Thus a rising section is obtained in passing from north to south, the whole having an average inclination of from 30° to 40°. These beds

* *Trans. Royal Geol. Soc. of Cornwall*, vol. iv. p. 383.

† *Geol. Report on Cornwall, &c.*, 1839, p. 94.

‡ *Geol. Report on Cornwall, &c.*, 1839, p. 152. This passage only became known to us after our own views had been formed.

§ *Trans. Royal Geol. Soc. of Cornwall*, vol. vi. pp. 1–11, 91–98, 173–180, 288–293.

|| *Trans. Royal Geol. Soc. of Cornwall*, vol. x. part 2, p. 47; *Journal Royal Institution of Cornwall*, vol. vii. part 1, p. 18; and vol. viii. part 2, pp. 162–205.

¶ *Quar. Jour. of Geol. Soc.* February, 1883.

are the equivalents of those exposed further north in Veryan Bay, and, as Mr. Collins points out, both have yielded the same organic remains, which identify them as belonging to the Caradoc formation.* There can be no doubt therefore as to these Meneage fragmentary series of rocks being intercalated among strata of Caradoc age, the higher portion of which, according to Professor Bonney, is faulted against the hornblende and talco-micaceous series; whilst the lower portions, forming a descending section towards Falmouth, may possibly represent the Llandeilo. Be this as it may, the fixing of this horizon not only simplifies much of the geology of the coast of Cornwall, from Veryan Bay southwards, but would serve to confirm the view that the "conglomerates" of the Meneage district are but the remnants of great deposits of ejected volcanic matter, which spread over a former widely-connected area. We have also examined a somewhat doubtful district between Torcross and the Start Point, in Devonshire, where highly metamorphic slates occur with others less altered above them, which have a strike nearly conforming to those in the area under discussion, but we failed to find any fragmentary series which we could correlate with those of Veryan Bay or the Meneage.

General Description.—Although the fragmentary deposits in the Meneage have not the same decided igneous appearance as those of Veryan Bay, yet careful attention will, we believe, reveal them to be due

* *Trans. Royal Geol. Soc. of Cornwall*, vol. x. part 2, p. 51.

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to the same cause. The resemblance of some portions of the beds to ordinary conglomerates is confined to those which lie between high and low tide, where the included fragments on the surface of the beds become rounded and waterworn, and where even the matrix of the rock itself is smoothed and polished, giving such exposures in some instances the appearance of a typical conglomerate. Above the wash of the tides, or where portions of the rock do not present direct surfaces to the action of the waves, many of these features which would serve to identify them with rocks of true aqueous origin can no longer be recognised; they resemble trap both in their homogeneous structure and mode of fracture. When the matrix of the rock is examined, it is found to be sharp and angular, consisting of lapilli-like material, and also including larger angular fragments of different rocks arranged throughout the paste or base in the most irregular manner. It passes sometimes abruptly from fine to coarse material without the linear arrangement common to conglomerates, and the whole has a highly indurated and vitrified appearance. There is also a complete absence of lines of deposition, and the rude bedding or stratification visible on the beach can scarcely be traced in the cliffs.

A few facts remain to be noted, such as the occurrence of quartz pebbles, and also fragments of hornblende slate, found by De la Beche, Budge, and Bonney. Another feature prevailing throughout the whole of these beds of volcanic rocks is the pre-

valence of iron as a colouring matter, giving rise to much variety of shade, passing from yellow and brown to pale and deep red. The iron has doubtless been supplied by the ejected materials, and its presence is so marked as to clearly define, even at a long distance, the line of junction between the tuffs and slates, the former producing a strong contrast to the uninterrupted and monotonous colour of the latter.

The beds generally begin as fine-grained deposits, some of them strongly resembling fine volcanic sand, passing into fine and coarse grained ash or tuff and breccia, and made up of huge angular and semi-rounded masses of local rocks, and also of vesicular and scoriaceous trap, passing again into less coarse materials, until they shade into the overlying slates which sometimes mark several renewals of the ejected matter. Both the over and the underlying slates at the junctions contain thin bands of fine mud, highly coloured by the presence of iron.

There also occur many slaggy masses of rock among the slates, and likewise what we believe may be a volcanic bomb, near Carne, to which we refer in detail in our description of the coast sections.

We sent Professor Judd a piece of rock from Caermenow, and he wrote in reply:

"The specimen you send, judging from the fractured surface, has every appearance of being a tuff; indeed I have very little doubt that it is so from the appearance of the rounded decomposed felspar and other minerals, and general aspect of the rock.

"It may be well to remember, however, that some

of the rocks called porphyroides strangely simulate the character of true tuffs."

We sent two specimens from the Nare Head to Dr. Archibald Geikie, who described them as follows:

"One is a breccia, most probably of volcanic origin; the other is a piece of greywacke, with apparently an admixture of the kind of felspathic cement which contemporaneous volcanic action would have supplied. So far as one can judge from these fragments I would expect to find in their neighbourhood associated lavas and tuffs, interstratified with the ordinary sedimentary strata."

We subsequently sent Dr. Geikie two specimens from a bomb-like mass south of Ligwrath Point—one from Ligwrath Point, one from the junction with the slate, near Parbean Cove, five from Caermenow cliff and quarries, four from the Gillan and Flushing districts, two from the hills north and south of Tregonwell Mill Bridge, one from a quarry in Tregonwell farm, one from Treworgie mill, and one from Tregevas quarry, near St. Martin's. Dr. Geikie wrote:

"With two exceptions all your specimens are volcanic tuffs. In most of them fragments of slate and quartz pebbles play a large part—some of them are fine felspathic tuffs, others are breccias.

"The two exceptions are from the bomb-like mass. The rock appears to be a fine micaceous greywacke or grit."

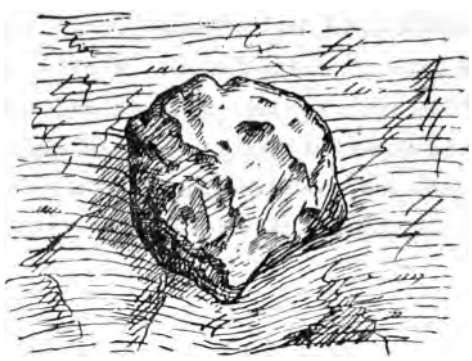
Professor Bonney very kindly made a microscopical examination of some specimens, the result of which

shows that fragments of many varieties, both of aqueous and igneous rocks, are present, and that the structure and general aspect of the fragments suggest that they have been derived from scoria and flows rather than from intrusive masses.

Coast Sections.—The first indications of these ashy slates and fragmentary rocks are found on the north shore of Gillan Creek, about half a mile west of St. Anthony Church, among slates dipping southward. As the north shore of the creek is followed inland, beds of distinct tuff and breccia become visible, and prevail to near its termination. On rounding the head of the creek to its southern shore the same beds become repeated, as they strike in this direction.

About 200 yards north-east of Carne we find the bomb-like mass already mentioned. It is rudely circular, about three feet in diameter, of very igneous aspect, in part indurated, vesicular, and scoriaceous, having the appearance of a mass of rock which has been subjected to the heat of a furnace. It lies embedded in the slate which has not the least affinity to it, the line of demarcation between the two being sharply defined; its lower portion depresses the slate for about a foot beneath it, as if it had fallen from a considerable height and with much force upon the soft mud which was being accumulated at the time. The upper layers of the slate on each side of it and above it are undisturbed, and were apparently deposited immediately after its fall. While we would not dogmatically assert this to be the true explanation of this curious mass, it appears to us to be more

difficult to conceive it to have been transported and placed in its present position by any other means; and even if it were carried along by the force of water to its present site, yet it still retains all the essential characters of an ejected mass. Close beside it, on the right, is another block of smaller size, rudely circular in shape, more compact, and much less vitrified in appearance, which may have had a similar origin.



BOMB-LIKE MASS IN GILLAN CREEK, NEAR CARNE.

Farther to the east, about sixty yards from Halamana Cottage, in the direction of Flushing, coarse breccia and tuffs are seen in the cliff. The included fragments are often of large size, both semi-rounded and angular, composed principally of the local rocks, but containing also igneous masses, the whole cemented by an ashy matrix. On the northern side of Flushing Cove a breccia of very large included blocks is seen in the beach and cliffs, becoming rather less coarse near the upper portion

of the bed, where the included fragments are very angular.

The tuffs and breccia are again overlaid in Flushing Cove by the regular slates in strict conformability; so that this would appear to form the first or lowest series of fragmentary beds, the whole having an approximate thickness of about 200 feet. There is, however, much local variation in the thickness of the tuffs, which seem to occur in lenticular or wedge-shaped masses.

Above all these slates comes another series of tuffs and breccias, forming the most important of these deposits. Their junction and lowest beds are well seen at the south extremity of Flushing Cove, where they begin with fine-grained ash, becoming coarser and more typical in their higher beds. Their strike is nearly east and west. They reappear in great force at Caermenow, beginning about the middle of Men-âver Beach with thin bands of fine-grained ash and ashy slate discoloured by iron at high angles with abnormal strike, passing, as we proceed east, into tuff and breccias, and disappearing as we approach Parbean Cove, where the beds again become suddenly disturbed, standing almost perpendicular, and inclining from either side with W.S.W. and E.N.E. dips. These disturbances are, however, of very limited extent, and seem to be due to a flexure of the thinner beds. Crossing to the east side of the Nare Point we have the Parbean beds and junctions repeated in Polnare Cove.

Proceeding south from Polnare Cove, the tuffs

predominate, and display the same aspect as those at Caermenow, which are indeed the lowest of the series exposed at that place. Immediately south rises the bold and lofty headland of the Nare, the intercalated slates disappearing, the tuff becoming coarser, and passing into breccia of huge blocks made up of masses of slate, quartzite, and igneous rocks, all contained in a paste or matrix of coarse felspathic tuff. This marks the highest portion of the Head, the coarse breccias, &c., having resisted denuding and wasting agents, and been left towering high above the general surface. Its structure and composition cannot be properly studied or understood without descending to the sea level beneath it. As we proceed southwards towards Ligwrath Point coarse breccias predominate, passing at places into ordinary tuff, and ashy and ordinary slates, showing that deposition was going on at the same time as ash and fragments were being ejected. Ligwrath Point is chiefly composed of this muddy felspathic matter with tuff and breccia, enclosing angular pieces of slate, &c., projecting beyond the adjoining coast in consequence of the hard and tough nature of its rock.

About 500 feet south-west of Ligwrath Point, as indicated on the map, is a spherical, concentric mass of rock, about seven feet in diameter, only about one half of which remains. At first sight it looks like a bomb; the outer shell is greyish, hard and tough; the interior is dark and decomposed, containing small plates of mica, and what appear as crystals of

quartz. The specimens described by Dr. Geikie as fine micaceous greywacke or grit are from this mass. Its separation from the adjoining rock is not well defined; but its concentric form, though probably concretionary, affords a curious and interesting study.

Southward of Ligwrath Point the rocks rapidly lose their ashy character, and slates, &c., continue to Porthallow, where Professor Bonney describes them as faulted against the hornblende and talco-micaceous series of the Lizard district, which are regarded by him as of Archæan age.

The thickness of this last or highest group of beds is considerable. Measuring it from the junction in Parbean or Polnare Coves to its termination south of Ligwrath Point, it cannot be less than 1400 feet. This must not be taken as a guide to the more inland portions, because of its lenticular shape and the rapid alterations it undergoes to the west.

Inland Sections.—The task of tracing the beds of tuff, &c., in an inland direction becomes rather difficult, as they not only rapidly thin out in their westward course, but also alter much in texture, and lose most of the well-marked features which distinguish them on and near the coast, becoming more finely grained, and containing but a small trace of ashy matter, as they approach the opposite coast. The line of separation corresponding to the two distinct deposits seen on the Coast must therefore be regarded as more or less arbitrary. The lowest group of beds, best seen at Halamana and the north end

of Flushing Cove, appear to strike in an inland direction a little way south of Manaccan, where splendid sections on the roadside are laid open. They are also traceable, but in a much more modified form, to Trelowarren, and even beyond, where however they lose much of their ashy character. The road sections exposed at Manaccan assume the appearance of a regular trap, for which the rock might be readily mistaken; but its ashy character can be distinctly made out, its compact and trappean aspect being due, we think, to pressure and subsequent metamorphism. Farther to the south-west, and therefore on a higher horizon, we again meet with tuff in several exposures and quarries south of Tregonwell farm, and in Trelawry farmyard, &c. It has here the appearance of a trap of felspathic type, even more solid and compact than at Manaccan. It, however, possesses none of the features of igneous flow; it is earthy, and its fragmentary character can be distinctly made out by the lens.

Foci of Eruption.—Over the area occupied by the tuffs there are no indications, as far as we are aware, of any neck or vent from which the ejected matter might have been blown, nor do we know of any at the Nare Head, Veryan Bay, where the complementary beds of tuff occur. There is greenstone in that neighbourhood which does not exist at the Nare Head, Meneage, although a similar greenstone occurs not far to the south, forming the Manacles Point. We are inclined to seek for such an ancient orifice or centre of eruption towards the Lizard district, or to

some point now submerged between the Veryan Bay and Meneage deposits. De la Beche reasoned conversely on the serpentine of the Lizard district, being formed at no distant date from the "trappean rocks and conglomerates of the Nare Head,"* in Veryan Bay, and we think there is much to support this view.

When we reflect on the large variety of igneous products, extending from the Manacles Point to the Lizard, we are led to conclude that they are not such as would have resulted from a mere flow of these igneous products on the surface, but rather such as could only have been formed at a great depth below the surface, and under much pressure. We think it probable that most of them belong to one geological epoch, although they frequently traverse each other.

During the formation of some of these formerly deeply-seated igneous masses, the tuffs of the Meneage and Veryan districts may have been showered out without any of the molten matters which formed the serpentine, diallage rock, and greenstone coming to the surface among the Meneage beds, although they did so to a small extent in the Veryan district. The occurrence of these three varieties of Lizard rock near Veryan Bay are cogent arguments of themselves to prove that the centre of activity lay within the area indicated; while the existence of fragments of hornblende slate in the Meneage beds are almost equally

* *Geol. Report on Cornwall, &c.*, 1839, p. 99.

so, as these may have been blown with other ejecta from the Lizard district.

Conclusion.—These "conglomerates" have been described by De la Beche as three distinct beds, the first occurring at Flushing, the second between Gillan and Nare Point, the third towards Carnmere. The division between the second and third beds we do not consider well defined; there may be a few beds of these slates intercalated, but these are charged with ashy matter. We are inclined to think that the separation of the tuffs into even two groups, marking long intervals between the showers of ejected matter, is somewhat doubtful. The greatest pause in the activity seems to be marked by the intercalated slates of Flushing Cove, but even this is not wholly to be depended on. The ejection of the tuff and the deposition of the slate were taking place simultaneously, and much ashy matter might be drifted and heaped together in one locality, and little or none in another. This is a common phenomenon with accumulations of ash, the rapidly altering thickness of the beds and the lenticular form being most characteristic. It is therefore probable that the whole of the tuffs may only mark one great period of ejection with intervals, perhaps numerous, of partial repose and activity.

Another point we would urge is, that the tuffs are of sub-aqueous origin; that is to say, they fell into and became assorted by water, and at a time when the ordinary muddy sediments which form the slates were being deposited. This explains the numerous interchanges of slate shading into ashy slate, fine and

coarse grained tuff, and *vice versâ*. It also explains some of the anomalies and indefinite characters presented by rocks near the junctions. Not only is much of the tuff mingled with ordinary detritus conveyed by currents, and spread over the sea-bottom, but much of the tuff itself may have been subject to attrition during its deposition, thus further complicating its true history.

THE RAISED BEACHES ON PLYMOUTH HOE.

By R. N. Worth, F.G.S.

In the course of a brief note upon "Teeth from a Stonehouse Bone Cave,"* communicated by me to this Society in 1882, I directed attention to the existence on Plymouth Hoe of two classes of recent deposits—a detritus of Dartmoor or associated origin, occupying depressions on the ridge of the Hoe, and filling fissures in its limestone rocks; and raised beaches, somewhat more than half-way down its sea face. Mr. N. Whitley has regarded both the fissure deposits and the Raised Beaches as examples of "drift."† The object of this paper is to put upon record the opening, in July last, of the finest section of "Raised Beach" that is known to have occurred in connection with the Hoe, and probably the most noteworthy of the many raised beach exposures of this Western promontory. Incidentally the distinction between the river deposits of the upper part of the limestone plateau and the beach will be rendered clearly apparent; but I do not wish to make any special reference to the former beyond the fact that I have found in them

* *Trans. Roy. Geol. Soc. Cornwall*, p. 167.
† *Ibid.* p. 140.

recently, in addition to granitic and schorlaceous materials, pebbles of a hornblendic trap, which were identifiable as derived from a rock occurring on the flanks of Dartmoor, towards Tavistock, and pebbles of a peculiar radiated quartz, which I have only found elsewhere on the edge of the Moor, near Sheepstor. The river alluvium is probably therefore associated with the Plym and its tributaries, or rather with the ancient river system which they now represent, and which was evidently of much greater magnitude and importance, and embraced a wider watershed.

The Hoe Raised Beaches attracted notice more than sixty years ago. The earliest published record is by the Rev. Richard Hennah, F.G.S., in 1817,* and his observations were summed up a few years later in his "Lime Rocks of Plymouth."† That Mr. Hennah was the discoverer of this beach, first distinctly exposed by the cutting of a road round the Hoe in 1816, is stated by Dr. Edward Moore.‡ In 1832 the Beach, as it then appeared, was described by Sir Henry de la Beche,§ and it was subsequently mentioned by him, in 1839,‖ as one of the most worthy of observation in the Western Counties. In the latter year, however, it was not only described, but in part figured by Mr. J. C. Bellamy,¶ and his account is supplemented by that of Dr. Edward Moore, already cited, in 1841.

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* *Geol. Trans.* 1st series, iv. p. 412. † p. 58.

‡ *Rep. Brit. Assoc.* 1841, *Trans. Secs.* pp. 62, 63.

§ *Geological Manual.* ‖ *Rep. Dev. Corn. and West. Som.* p. 428.

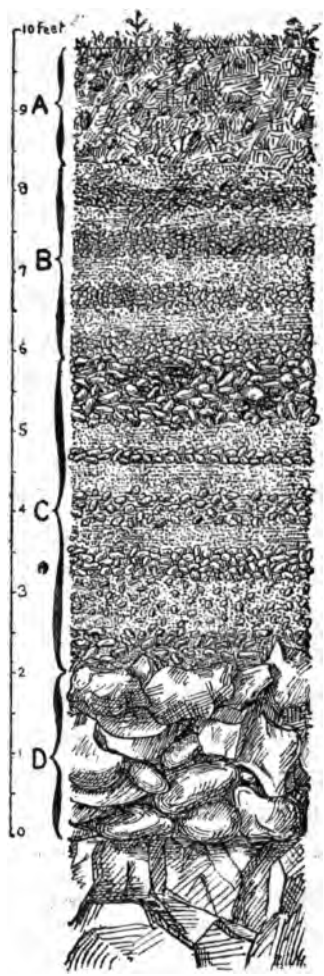
¶ *Nat. Hist. of South Devon*, pp. 114, 115.

For some forty years from the date of Dr. Moore's paper "the Raised Beach on the Hoe" was almost a matter of pure history. On the west it had been wholly destroyed by quarrying operations; on the east what might remain was hidden by the turf, and only a few insignificant fragments were visible on the edges of the cliffs next the sea. In June last, however, some alterations were made in the road at the junction of the two divisions of the Hoe, in the course of which the hill was cut back several feet. As a result the Raised Beach was once more exposed, and more effectively than at any previous time. Fortunately for the interests of geological science, the workmen were under the direction of Messrs. Harris, Bulteel, and Co., of the Naval Bank, Plymouth, the owners of the West Hoe, and Captain Daubeny, the partner within whose province the work came, at once saw the importance of the discovery, and afforded every facility for development and examination. While the accounts of Mr. Bellamy and Dr. Moore are fully borne out in their main features, it now appears that on several points they require supplement and emendation.

The Beach at its most perfect exposure was some eight feet six inches in thickness, varying but slightly over a length of half a dozen yards. Its top when first opened was forty feet above the highest point of the modern beach below; but as the men worked back into the hill it ascended with an easy slope. When they finished excavating it had therefore been traced to a point three to four feet higher above the

SECTION OF HOE RAISED BEACH.

JULY, 1884.



present sea-level, and its termination had not been reached.

The section was characterized by four well-marked divisions. At the top, immediately beneath the turf, was (A) a head of earth mixed with rubbly angular stones, 18 inches in thickness. Next came (B) 2½ feet of sand and very small pebbles in layers, apparently eight in number, fairly equal in thickness and approximately horizontal, commencing with sand and ending with a mixture of the two constituents. Below this (C) was a series of layers of pebbles and sand alternating, 3 feet 10 inches in total thickness. Some of the pebbles were of considerable size, ranging up to four and five inches in their longest diameter; but the bulk were much smaller, and a length of from one to two inches would include by far the greater number, while in some of the layers (there were nine altogether) still smaller stones predominated. As a rule the materials were well assorted, and only in three of the layers was there any noticeable admixture of pebbles and sand. Lastly (D) there came a bed of large blocks of stone, chiefly limestone with rounded edges, clearly waterworn, and ranging up to a couple of hundredweight, and even more. This stratum was about two feet in thickness, and rested upon a shelf of rock sloping seawards. The general character of the Beach is best shown in the accompanying sketch. The conditions represented were fairly persistent at this point while the Beach remained open to examination.

The condition of the Beach closely answered to the

description of Mr. Bellamy. The different layers exhibited varying degrees of cohesion; but while the upper beds as a rule were crumbly—yet consolidated patches were of frequent occurrence—the lower were in parts so solid that they defied the pick, and had to be broken up by blasting. Here and there the smaller pebbles appeared to have been considerably influenced by pressure, and had assumed an aspect of remarkable solidity, in which their individuality was partially lost; but the main cause of cohesion was the infiltration of waters charged with carbonate of lime from the adjacent limestone beds of the Hoe, which had deposited in the interstices and cemented sand and pebbles together in a very compact mass.

The most remarkable feature of the Beach is the character of the materials of which it is composed. The whole of the existing beaches on the shores of the Sound are in the main formed from the rocks immediately contiguous, and vary in character with the locality. The chief exception is the occurrence of flints in some little quantity on the beach at Rum Bay, under Staddon Heights. These are not to be identified with the flint shingle that forms so general a constituent of beaches along the southern coasts of Cornwall and Devon, and I am not at all sure that they have not a ballast source. The modern beaches at the Hoe are mainly formed of the limestone which composes that historic bluff, and are clearly of directly local origin.

The ancient Beach, however, is wholly different in constitution. Except in the lowest or boulder bed,

limestone is of quite exceptional occurrence. Pebbles of red and grey grit are much more frequent, and fragments of slate occasionally occur. The predominating constituent is, however, the felspathic trap, which occurs in association with the Triassic conglomerate on the western shore of the Sound, in Cawsand Bay, a rock alluded to by Dr. Moore as porphyry. The granitic sand of which he speaks as present I have been unable to detect, and he seems there to have been in error. A careful examination of the Beach sand, even without the aid of a lens, shows that it is composed of precisely the same materials as the other portions of the deposit, and the use of the lens enables every fragment to be identified. There are certainly some quartz grains, but they are proportionately unimportant, and quartz pebbles in varying quantity are to be found on every existing beach in the neighbourhood. The only beach in the vicinity that presents any similarity to this ancient Raised Beach is that at Cawsand, two miles distant, and in constitution the two may be regarded as practically identical.

This opens up a very interesting and somewhat difficult question. There can be no doubt that the materials of this ancient Beach have been carried to the Hoe from Cawsand Bay round the eastern point of Drake's Island; for a boulder of upwards of two hundredweight, derived from an exposure of a species of trap-rock, which occurs in this neighbourhood only on the Island, was found in the basement bed. At the time of the formation of the Beach, what is

now Drake's Island evidently formed part of the mainland of Mount Edgcumbe, to which it is still joined by a partially tidal reef. The drift to the eastern end of the Island was therefore along shore, and easily explicable. It is not so clear how the materials were carried across the channel between Drake's Island and the Hoe. It is true the distance is but half a mile, but for some couple of hundred yards the interval is occupied by a portion of a long deep-water trough, which extends from a point near Mount Batten up the Hamoaze to Saltash. This trough is at one spot twenty-five fathoms in depth at low water, and between Drake's Island and the Hoe it reaches fifteen. It is not easy to conceive the conditions under which the *débris* of the Cawsand rocks would be driven past such a barrier as this, especially when we bear in mind that at the time of the formation of the Beach what is now the bottom of this channel must have been forty feet lower even than it is at present. This seems to indicate that although the general contour of the shore must present much the same leading features as in the Raised Beach era, considerable modifications have otherwise taken place within this limit. For one thing the Hoe promontory was clearly an island, and so were what are now the headlands of Devil's Point and Mount Batten.

The Beach has yielded several varieties of shells. Dr. Moore recorded Purpura, Patella, Buccinum, and Ostrea; and I have found Patella, Buccinum, Ostrea (including one very old valve, minutely bored), and fragments apparently of Tapes. Cardium occurred

in the earth immediately over the Beach, and was possibly, though not certainly, associated with it. Bones and teeth of Ox were found in the overlying head, but no bones occurred in the Beach. A few nodules of umber, evidently the result of decomposition, were mixed with the pebbles.

NOTES ON THE FOSSIL FORAMINIFERA OF THE ST. ERTH CLAY PITS.

By Fortescue William Millett.

The amount of time required to work out the fauna of a deposit, so rich in microzoa as the St. Erth clay, is so considerable, that it has been judged advisable to take this opportunity of calling attention to the subject, rather than to wait for the completion of an exhaustive report.

There are in the St. Erth clay-pits, at least three kinds of fossiliferous clays, bearing a general resemblance in the organisms which they contain, but at the same time differing slightly in detail. These organisms consist of mollusca, polyzoa, ostracoda, foraminifera, and various remains of echinodermata. Omitting the mollusca, they are so abundant and so evenly distributed, that any portion of the clay the size of a pea, taken at random, will certainly be found to contain a considerable number of specimens.

The list of foraminifera appended treats only of those varieties, which are most common in this deposit, leaving new and doubtful forms for further consideration.

The most noticeable feature in the foraminifera of

this deposit, is the utter absence of the arenaceous forms, not one specimen having yet been observed. The porcellanous forms are very fine individually, but do not occur in any great variety. Of the hyaline genera, *Lagena* is exceedingly well represented, in variety of forms, as well as in number of specimens. Next comes *Discorbina*, in which the examples, mostly of the *D. parisiensis* type, are as large and fine as any known.

The commonest form of all, is a variety of the plano-convex *Polystomella*, constituting the genus *Faujasina* of d'Orbigny. Hitherto this has been found only in the Upper Cretaceous formation of Maestricht, and in the Eocene of the environs of Paris.

Another very fine form is the *Rotalia punctato-granosa* of Seguenza, found by him in the Upper Miocene of Reggio, in Calabria, Italy. It has not hitherto been recorded from any other locality or formation.

Most of the specimens are in excellent condition, being as clear in substance and sharp in sculpture as the recent ones to be found washed up on our shores at the present time.

Taken as a whole they indicate such a fauna as might be found in the shallow seas of a sub-tropical climate. In all probability they belong to the Tertiary period, but their exact position cannot be determined without further investigation.

LIST OF FORAMINIFERA

FROM THE CLAY OF ST. ERTH.

Miliolina tricarinata, *d'Orb.*
oblonga, *Montagu*, sp.
seminulum, *Linn.*
brongniartii, *d'Orb.*
subrotunda, *Montagu*, sp.
secans, *d'Orb.*
selerotica, *Karrer.*
Spiroloculina limbata, *d'Orb.*
Textularia saggitula, *Defrance.*
Bulimina elegantissima, *d'Orb.*
marginata, *d'Orb.*
pupoides, *d'Orb.*
Virgulina Schreibersii, *Czjzek.*
Bolivina plicata, *d'Orb.*
punctata, *d'Orb.*
dilatata, *Reuss.*
lævigata, *Williamson*, sp.
Cassidulina lævigata, *d'Orb.*
crassa, *d'Orb.*
oblonga, *d'Orb.*
Lagena lævis, *Montagu*, sp.
gracillima, *Seguenza*, sp.
apiculata, *Reuss*, sp.
globosa, *Montagu*, sp.
squamosa, *Montagu*, sp.
melo, *d'Orb*, sp.
caudata, *d'Orb.*
sulcata, *Walker and Jacob.*
striata, *d'Orb.*
semistriata, *Williamson.*
marginata, *Walker and Jacob.*
lucida, *Williamson.*
lævigata, *Reuss.*

Lagena ornata, *Williamson*, sp.
orbignyana, *Seguenza*, sp.
quadrata, *Williamson.*
var. semialata, *Balkwill and Millett.*
lyellii, *Seguenza.*
trigono-oblonga, *Seguenza.*
trigono-marginata, *Parker and Jones.*
Nodosaria pyrula, *d'Orb.*
Dentalina brevis, *Reuss.*
guttifera, *d'Orb.*
Cristellaria crepidula, *Fichtel and Moll.*
rotulata, *Lamarck*, sp.
Polymorphina communis, *d'Orb.*
oblonga, *Williamson.*
compressa, *d'Orb.*
Uvigerina angulosa, *Williamson.*
Globigerina bulloides, *d'Orb.*
Discorbina globularis, *d'Orb*, sp.
parisiensis, *d'Orb*, sp.
rosacea, *d'Orb*, sp.
orbicularis, *Terquem*, sp.
Truncatulina lobatula, *Walker*, sp.
ungeriana, *d'Orb*, sp.
haidingeri, *d'Orb*, sp.
Pulvinulina elegans, *d'Orb*, sp.
auricula, *Fichtel and Moll.*, sp.
Rotalia beccarii, *Linn.*
punctato-granosa, *Seguenza.*
nitida, *Williamson.*
calcar, *d'Orb*, sp.
Patellina corrugata, *Williamson.*
Faujasina, sp.
Polystomella striato-punctata, *Fichtel and Moll.*, sp.
crispa, *Linn*, sp.
macella, *Fichtel and Moll.*, sp.
craticulata, *Fichtel and Moll.*, sp.
Nonionina depressula, *Walker and Jacob*, sp.
scapha, *Fichtel and Moll.*, sp.
stelligera, *d'Orb.*
umbilicatula, *Montagu*, sp.

THE UMBER DEPOSITS AT ASHBURTON.

By R. J. Frecheville, F.G.S.,
One of H.M.'s Inspectors of Mines.

Associated with the clay-slates skirting the eastern flank of Dartmoor are several patches of limestone; one of these commences at the town of Ashburton, and extends some two to three miles in a north-easterly direction. The beds composing it dip to the south-east, and consist in their upper portion of a massive grey rock in places largely quarried for agricultural and building purposes. The lower beds approach dolomite in character, and close to Ashburton, where they are separated by only a very thin band of clay-slates from the greenstone hill north of the town, have by their decomposition formed large deposits of umber that have been continuously worked for the last thirteen years.

The nature of the change that has taken place can be readily understood from the following analysis, made by Mr. J. J. Beringer, of Camborne, the county analyst. No. 1 being a sample of the unchanged limestone, and No. 2 a sample of the umber in its natural state.

No. 1.		No. 2.	
Water (lost at 100° C.) .	·8	Water (lost at 100° C.) .	65·0
Carbonate of lime .	46·7	Combined water . .	4·8
Carbonate of magnesia .	41·0	Lime . . .	·6
Silica . . .	3·3	Silica . . .	12·3
Carbonate of iron .	2·6	Sesquioxide of iron .	6·3
Carbonate of manganese	2·5	Binoxide of manganese	10·0
Undetermined and loss	3·1	Loss and undetermined	1·0

The carbonates of lime and magnesia have doubtless been removed by the solvent action of water containing carbonic acid, thus giving rise to the formation of deposits of umber from twenty to thirty feet in thickness. If we compare the relationship between the iron and manganese oxides in the original stone and the umber, it will be seen that in the latter the proportion of manganese oxide has largely increased. This is probably due to the greater readiness with which manganese compounds peroxidize.

That the dolomitic limestone, from which these deposits originate, is of very variable composition is shown by the capricious way in which it has decayed; large masses of unchanged rock of the most curious shapes can be seen cropping up surrounded by umber, and in the centre of lumps of umber are often found pieces of limestone.

It is not at all unlikely that the neighbouring mass of greenstone has played an important part in the chemical reactions that have occurred; for both through the strata at its base, which are much broken and disturbed, and the umber deposit itself, strings and veins of iron and an impure manganese ore ramify.

The deposit is worked by removing the overburden, consisting of from three to four feet in thickness of loam, and then sinking large rectangular pits in the umber till the unchanged rock is reached. The timber supporting the sides is then removed, the pit filled up, and another commenced alongside. The umber obtained, after being stamped in the usual manner, is ground under edge runners, and the liquid mud pumped up to tanks, where it remains until it settles sufficiently to be dug out; the drying is then completed in a manner similar to that practised in the preparation of china clay.

The umber is used for making the so-called silicate-oxide paint, as a colouring matter for the coarser kinds of cloth, and in the manufacture of brown paper.

The output of umber from this deposit for last year (1883) was 2,766 tons, the price of which, delivered on the railway at Ashburton, averaged about 25s. per ton. In the neighbourhood of Combmartin beds of limestone occur interstratified with the clay-slates, and where they are intersected by lodes or the master joints of the district, umber deposits occur, but not nearly on such an extensive scale as at Ashburton.

Small deposits of umber have also been found near Milton Abbot, and at Veryan, some seven or eight miles to the south-east of Truro, in both cases as a result of the decay of limestone rocks.

NOTE TO ACCOMPANY A SPECIMEN OF NATIVE GOLD FROM LEADVILLE, COLORADO.

By C. Le Neve Foster, D.Sc.

Although the first discovery of rich argentiferous lead ore at Leadville, in Colorado, was made only ten years ago, the quantity of lead and silver produced has been so great, and the rise of the flourishing town in the heart of the Rocky Mountains so rapid, that this new mining locality is perhaps more generally known than many of the older but less successful "camps."

The mode of occurrence of the Leadville deposits has been carefully described by Mr. S. F. Emmons.* The ore consists of argentiferous sulphide, carbonate or sulphate of lead, associated with quartz, iron pyrites, red hæmatite, brown hæmatite, and sundry other minerals. It lies in the form of a flat vein, tabular mass or succession of irregular ore-bodies, at the junction of a sheet of intrusive porphyry, with an underlying dolomite of Carboniferous age. The ore-bodies appear to have been formed by a process of gradual replacement of the dolomite by metallic

* Second Annual Report of the United States Geological Survey. Washington, 1882. Page 203.

sulphides, which have subsequently been more or less entirely converted into oxidised compounds in the same way as the Cornish gossans.

It may not generally be known that in some places rich gold ore occurs. The specimen which I send came from the Lilian mine, which lies about three miles south-east of Leadville, and some 800 feet above it, or at a total elevation of 11,000 feet above the sea-level. At the time of my visit, in September, gold was being found at the base of the porphyry, or, in other words, at the very top of the ore-body. The gold is generally in the form of thin plates, and the quantity obtained is already of some importance.

Royal Geological Society of Cornwall.

THE SEVENTY-SECOND

ANNUAL REPORT

ETC. ETC.

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1886.

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PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN,—In reviewing the position of our Society for the past year, we may be satisfied with the maintenance of our numbers, and the condition of our Museum and Library. But we need to be reminded that constant study and frequent observation are indispensable for the steady progress by which alone geology can hope to maintain its place as a trustworthy and living science. In that department of geology which deals more especially with the succession of events which have moulded the form, and reared up the ancient life-history of the West of England, many questions yet await solution, many preliminary labours need to be undertaken. And it is in connection with the life of the long period, which preceded the advent of man to this earth, that I have in a sorrowful spirit to bring before you some facts respecting the losses we have sustained among our contemporaries; among those too who were most likely to throw a clear light on some of the subjects which have been shrouded in comparative obscurity.

It is only a few days ago that the scientific world received the sad tidings of the death of Mr. Thomas Davidson, F.R.S., an honorary member of our Society. This well-known cultivator of palæontological science completed, a few years since, a painstaking description of the Brachiopoda of the older Cornish strata, from specimens lent to him from this Museum, and of which most of those present are aware that a large portion are difficult of determination, and would require the close study of a thoroughly experienced and learned investigator. Such, however, was Davidson; at the same time one of the most modest, most single-

minded, and most kindly-hearted of men. In 1851, and residing for many years past at Brighton, he devoted himself more especially to the study of the Brachiopoda, and to the figuring and description of the "British Fossil Brachiopoda," published from time to time in the handsome volumes of the Palæontographical Society. This chief work of his life he was successful in completing by the publication of the concluding supplements in December, 1884. The volume which was issued for 1881 included a long list of the Brachiopoda belonging to the Devonian and Silurian formations of this county, and Plate xlii. is almost wholly occupied by figures of specimens supplied to him from our Museum, for the use of which he inserted at page 327 a handsome acknowledgment. One of the most interesting portions in this monograph is that devoted to the extensive series of the Budleigh Salterton fossils, imbedded in rounded pebbles, and comprising a discussion of the various hypotheses by which it has been sought to explain their occurrence and trace them to their mysterious place of origin. What Davidson did for this county includes of course but a fraction of the marine fauna of Cornwall contained in the earlier strata, but it constitutes a classical work, and speaks with an authority second to none in the world.

Let us now turn our attention to phenomena relating to a very different period in the earth's history—to the sands and clays, with imbedded marine shells, discovered some three years ago at St. Erth. I had the pleasure to advert to this interesting topic last year, when it had attracted the attention of British and of Continental geologists in a high degree; and we had every reason to hope that the full bearings of the subject would be amply treated by the two best authorities we could boast in Great Britain—Mr. Searles Wood and Dr. Gwyn Jeffreys—both of them thoroughly versed in the Mollusca of the Tertiary strata, and both of them enthusiastically interested in the new find.

Here I may not omit to mention with much satisfaction that it is to a member of this Society, and a near neighbour both of ourselves and of this remarkable deposit—Mr. Fortescue Millett, of Marazion—that we owe the publication, in the last number of

our Transactions, of "Notes on the Fossil Foraminifera of St. Erth," with a list of no less than seventy-one species. Those who can appreciate, on the one hand, the delicacy of manipulation needed in dealing with these minute objects, coupled with the learning required for making the comparisons, and, on the other hand, the interest of a subject adding such rich material to our British Tertiaries, will rejoice that a Cornishman has proved himself equal to the occasion. I can assure you that those brief "Notes" have attracted a vast amount of attention among geological enquirers, and they will doubtless form, when added to by contributions which we may hope to obtain from time to time, a valuable chapter in this piece of yet unwritten history.

Let us pass to the Mollusks, which, from the size and good preservation of many of them, were first noticed at this place. In the outset they were mistaken for glacial shells, and their clays for the "boulder-clay." But as soon as, through Mr. T. Cornish, some of the specimens got into the hands of Mr. Searles Wood, they were recognized as Tertiary; and Mr. Robert Bell, F.G.S., and Dr. Gwyn Jeffreys, F.G.S., were called in to consultation. Mr. Wood, although only fifty-four years of age, had been for years a great invalid; and whilst totally unable to go out, devoted himself to his favourite studies with unremitting industry. The shells and the clay, which he got sent to him from St. Erth, seemed to enable him to triumph over infirmity and pain. It is touching to read of his last days, when occupied in the farther examination of the subject matter, after he had communicated a paper to the Geological Society of London, read November 5th, 1884. You will, I am sure, feel a sympathy with this dying investigator when I quote Professor Bonney, the President of that Society, who gives an extract from a letter, dated December 6th, 1884, from Mr. Searles Wood. Speaking of a recent severe attack from which he had in part recovered, but which was complicated by an ailment in one foot, he adds: "This compels me to maintain a recumbent posture all day as well as night; but it has not prevented my renewing my close examination of the St. Erth clay for several hours a day. This clay, however, is so sterile, that I often work for

days without finding a perfect shell or a fragment worth anything for determination; and I fancy that no one who had not perforce the leisure that I have, and a rather exceptional perseverance, would work at it as I am doing, and as I hope for many months yet to do." It was not so written; eight days later he passed away.*

No one was more desirous or better fitted to pursue the task of determining the history of the St. Erth beds than Dr. Gwyn Jeffreys, originally of Swansea, but resident for many years past in and near London. He began his conchological studies very young, having read a paper to the Linnæan Society at the age of 19; and he had made use of frequent opportunities of carefully studying collections all over Europe of recent and of Tertiary shells. His thorough knowledge of living forms, and familiarity with the beautifully perfect contents of the Italian Tertiary beds, gave exceptional value to the opinions he expressed on this, the uppermost portion of the geological scale. He admitted that he was not quite in accord with Mr. Searles Wood as to some of the species, and as to the proper position of the entire group, and foresaw that a long and critical recomparison would be needed for deciding these various questions. But, alas! for the uncertainty of human plans. On the 22nd January last he was dining in company of scientific friends as the genial Treasurer of the Royal Society Club, on the 23rd he attended—cheerful and hale-looking, and discussed with me—the Royal Institution Friday-evening lecture, given on that day by his son-in-law, Professor Moseley; and the next morning was carried off by a sudden seizure.

It adds something to the singular character of this fatality, that both these ardent devotees of natural science passed all their younger years in the legal profession, not as barristers with a liberal allowance of long vacation, but as hard-working solicitors. It is a comforting and elevating spectacle in both cases to see how the charm of their favourite science threw a halo of brightness on the closing days of their life.

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* *Geol. Soc. Lon. Anniv. Address*, 1885, p. 15.

The list of some fifty species, prepared by Mr. Searles Wood for his paper on the St. Erth deposit, was subsequently withdrawn by him, by permission of the Council of the Geological Society, for the purpose of farther revision; and it may therefore be some time before we shall have the advantage of examining a full catalogue. Without doubt many of our members, as well as others interested in the natural history of the British islands and seas, will desire to know the names and characters of these early settlers on the Cornish shores; and I may be pardoned for placing before you some excerpts from the paper, which will serve as an approximate means of comparison with lists from other Tertiary localities.

Three of the species; viz., *Cyprœa avellana*, *Nassa granulata*, and *Melampus pyramidalis*, are Red Crag forms not known living. The first two are probably also species of the Miocene of Touraine, as *Cyprœa affinis* and *Buccinum graniferum*, of Dujardin.

The great muricated form of *Calyptrœa chinensis* does not occur in the Miocene of France, the form there being small. A large form of the species is figured by Hörnes from the Vienna basin.

Nassa serrata and all the forms of it figured as distinct species by Bellardi, as well as *N. Emiliana*, do not occur above the Lower Pliocene. *N. serrata*, *N. Emiliana*, and one other species of the group (*N. bisotensis*, var. A), occur also in the Upper Miocene. None are known living.

Nassa recticostata is a species of the Upper Pliocene only. It is not known living.

Turritella triplicata and *Ringicula buccinea* do not live north of Vigo (lat. 42°), whence they range southwards to the Canaries, and through the Mediterranean. Both are among the commonest species of the Coralline Crag.

Nassa mutabilis, as well as all the Nassæ of that group, and *Euthria cornea*, as fossils, are only known in South European beds.

In the living state both these species range through the Mediterranean, but outside that sea their northernmost place of occurrence is Cadiz, in lat. 36° 30′.

Natica millepunctata is, in the living state, confined to the Mediterranean; but in the fossil it occurs in the Miocene and Pliocene of Southern Europe in general. The Coralline and Red Crag form *N. multipunctata*, was considered by Mr. S. Wood, sen., as not identical with it.

Artemis exoleta is not known from the Coralline Crag, but is regarded as a Miocene species. It is also a South Italian Pliocene fossil, and ranges living from Norway to the Mediterranean.

Of the other species obtained, save those peculiar to the deposit, most range in the living state from Norway to the Canaries, and through the Mediterranean.

One of them only is known to reach the Greenland or Spitzbergen seas also. Two range no farther south than Great Britain, as far as is yet known. The character of the Mollusca, as a whole, is essentially southern, no peculiarly Arctic shell having as yet occurred.

Both in the positive and negative aspects of the group (for none of the many peculiarly tropical genera that occur in the Miocene are present in it) we seem to have evidence of a Pliocene age for the bed, and, I think, on the whole, a preponderance in favour of Newer rather than Older Pliocene. The relation of the fauna is more in the direction of the Italian Pliocene, than in that of the Pliocene of North-Western Europe.

The analogy of the St. Erth deposit with certain beds in Normandy, will, it is to be hoped, be farther worked out when the lists are more complete. Professor Prestwich, of Oxford, has referred particularly to those of Bosq d'Aubigny, as exhibiting the same preponderance of Subappenine and Mediterranean species, with many Crag fossils, whilst the species appear to be different.

The comparison between the fossils thus recently brought to light so near to us with those of Normandy is confessedly under existing circumstances a difficult task, but already it suggests some curious conclusions. "We must," says Mr. Searles Wood, "as the case at present stands, infer either that Cornwall and Normandy, near as they are to each other, were at the time of the St. Erth deposit separated by a land barrier, or else that even the "Marnes à Nassa,"

described by Messrs. Vieillard and Dollfus, are older, and that the deposit of the Normandy Crag had ceased before the St. Erth deposit began." Mr. Wood's impression was that the latter was the case, for the fauna of the "Marnes à Nassa" seem to indicate an age intermediate between the Coralline and Red Crags, rather than, as it has been supposed, a Red Crag age.

Of whatever age the St. Erth bed may precisely be, however, it seems pretty clear that at the time of its deposition there was no communication from the South Atlantic and Mediterranean to the North Sea except round the north of Scotland; so that such of the southern species as had not been denizens of the North Sea during the Older Pliocene, and so lingered on there into the Newer Pliocene of the Red Crag, were prevented by the difference of nine degrees of latitude between Cornwall and the north of Scotland, and the consequent refrigeration northwards of the marine climate, from getting round into the North Sea.

Dr. Gwyn Jeffreys admitted at that time only forty-four or forty-five satisfactory species, of which he pronounced eleven or twelve to be recent, and thirty-three or thirty-four extinct. Of the latter only eleven were known to him from Tertiary deposits, four being of Miocene age, and all of them Pliocene, whilst twenty-two species were unknown to him either as Tertiary or recent.

Mr. Robert Bell, F.G.S., to whose labours in the same cause Mr. Searles Wood owed much of the valuable matter in his paper, in a letter to Mr. Fortescue Millett of the 2nd instant, announces the increase in the number of species of Mollusca determined, to seventy-five in all, besides varieties. Mr. Bell, it is satisfactory to learn, has with a good heart taken up the mantle which has fallen from our two lamented friends, and will proceed to carry on the study of all the Mollusca which may be gathered from this interesting fragment of a deposit of marine sediment.

Mr. Bell also states that he has four or five Polyzoa, two or three Echinoderms (plates and species), two or three Annelids, several Crustacea, and some fish vertebræ, and that he hopes to have a paper ready for the Geological Society of London about Christmas.

"As a deposit," he adds, "it is perfectly unique in the British Islands."

Those who have seen what remarkable results have been unfolded by this little patch of smooth hillside on the north of St. Erth will cast a glance of enquiry on the short course of the Hayle river, where between the sea and Trelubbus there are many places that might very likely harbour a continuation of these deposits. And looking across St. Ives Bay, to a distance of only thirteen miles across from St. Erth pit, they will light upon the bold headland of St. Agnes, and find there an accumulation of clays and sands which has aroused without satisfying the enquiries of all geologists who have visited the place. These substances, irregularly laid down on an uneven and wave-worn floor of killas, lead the observer at once to conjecture that they must hail from the Tertiary age; but the non-existence, so far as is yet known, of fossils has hitherto prevented any determination of the antiquity of the beds. The St. Erth fossils are found at ninety-eight feet above the Ordnance *datum*, the deposits of St. Agnes Beacon at about 300 feet; the first occupies, as far as we at present see, only an acre or two of surface, the second is spread like a collar round the shoulder of the hill, three quarters of a mile along each side, and about the same distance along the end. In both we have incontrovertible evidence of a great depression of this part of Cornwall at a not very remote geological epoch. Until however either some fossil evidence is obtained from the more northern locality, or some intermediate place shall reveal farther illustrative facts, we have no proof of a close connexion between the two groups of phenomena. Even at a time when no evidences of Tertiary age were known in the West nearer to us than Bovey, the comparison suggested itself to one of the most acute observers of the geology of these counties, who wrote nearly fifty years ago, in describing the sands and clays of Bovey and St. Agnes, words which may apply again to our new discovery: "They both probably belong to a class of deposits that may once have covered a considerable portion of the district under consideration, and which have been since removed, with a large mass of pre-existing rocks, to form that

varied surface we now see, and which is still undergoing different modifications."*

In concluding this notice of the present state of our knowledge of the undoubted Tertiaries of Cornwall, I trust the geographical feelings of members of this Society will not be shocked by the new deposit being stated in all the headings of Mr. Wood's paper to be at St. Erth, "near the Land's End," that idea of Cornish topography being of course taken from a Londoner's point of view.

In his annual address to you for 1883 my predecessor, Mr. Leonard Courtney, M.P., reminded us of the way in which the primitive ideas of the permanence of the features of the earth's surface had been dissipated by the advancement of geological views on the constant changes in the face of nature. It was just at the time that we were all excited by the accounts which were coming over of the fearful volcanic explosions which were taking place in the Straits of Sunda. Darkness as of midnight prevailing through the whole day, detonations which were heard for hundreds of miles, mountains shivered to their base, the bottom of the sea depressed over a large area, and thousands of human lives sacrificed. Many imagined that the accounts were exaggerations, few expected that we should so soon be possessed of satisfactory data which still farther excite our wonder at the marvellous scale of the phenomena which in the course of a few days wrought such tremendous changes.

It seems to result from various occurrences of late years that some of our ancient prejudices about the slowness and phlegmatic character of the Dutch nationality have to be much modified. Among other instances, M. Verbeck, who after the great eruption of Krakatão, in August, 1883, was charged by the Netherlands East Indian authorities to draw up a report on what had occurred, has, after long examination on the spot, completed a magnificent memoir on the whole of this unprecedented exhibition of volcanic forces. He appears to have sifted out the facts from amid the

* Sir H. De la Beche, *Report*, &c., 1839, p. 258.

mass of more or less isolated evidence, and from accurate comparison of the state of things before, with the ruin too prominently observable after, the eruptions of the summer of 1883. Some of these ought to be brought to the knowledge of the members of every geological society in order that they may be familiar with the effects of the mighty powers which, even in these older days of the globe, are brought into play by volcanic action. Readers of Sir Charles Lyell's treatises will remember his account of previous gigantic outbreaks of these agencies in the same regions of the earth, among the East Indian Islands; but we have now a more accurate description of a catastrophe probably more swift and violent than any other of modern times. Mr. Verbeck estimates that the average thickness of the ejected materials, in some parts of Krakatão, amounted to nearly 200 feet, that their dimensions were from a cubic yard to the finest dust, that they were shot out with a velocity greater than that of projectiles from the heaviest guns, and attained a height nearly six times greater than that of the highest mountains in the Himalaya, and that by his calculations a body of material was ejected equal to 18 cubic kilometres. A late number of *Nature* gives an illustration by the suggestion—imagine a box of ashes as large as Hyde Park, and as high as the dome of St. Paul's, a hundred of such boxes will give an idea of the mass of matter thrown out by Krakatão in 1883.

The detonations which accompanied this eruption were heard not only through a large portion of the Indian Archipelago, but even in Australia and Ceylon. Indeed, the area over which they were observed seems to have amounted to one-fourteenth of the whole globe, and the vibration of the air was sufficiently powerful to shake and in some instances damage houses and furniture, and to give the impression of earthquake movements; but one of the remarkable features of this great eruption was the absence, both before and during the crisis, of any true earthquake phenomena. It is singular too that in Australia, where seismic phenomena are not frequent, the days of the eruption were marked by more or less serious earthquakes; and it is suggested that sudden displacements of steam—perhaps of lava—occurred in the subterranean cavities,

caused by a change of pressure through the great discharge of lava and steam at Krakatão.

We all recollect the beautiful effects of highly-coloured sunsets and sunrises which were commonly ascribed to the particles of fine volcanic dust suspended in the higher regions of the atmosphere. We now learn that the air-wave which was produced by the explosion at 10h. 2m. a.m. on the 27th August probably made the tour of the whole world, and from the calculations based on a great number of observations, that it would require 35½ hours to perform the circuit. But of all these phenomena, perhaps the most interesting and the most awful were the sea-waves, especially that occasioned by the great explosion just referred to. The wave in question, rushing suddenly over parts of the land which no one dreamt could ever be reached by the sea, utterly destroyed a number of thickly-inhabited places, and sweeping back with irresistible force drowned thousands of the terrified natives. A single fact may give a notion of the effectiveness of such a wave as an agent of geological change, that the velocity was such as to reach Aden in twelve hours, a distance of 3800 nautical miles, usually traversed by a good steamer in twelve days.

Before passing to the ordinary business of the meeting, I lament to have to announce to you the decease in the past year of two of the members of our Society. Mr. Alfred Lloyd Fox—one of that well-known and highly-valued family, always so ready to take a part in any reasonable plan for increasing the well-being and intelligence of all classes of the community—was the eldest son of the late Alfred Fox. Without being himself a practical geologist, he took a general interest in the nature and progress of the sciences, and was noted as a leader among the friends of missions to Palestine and Mount Lebanon, objects to which he devoted most of his work.

Another member of the Society of Friends was Mr. Alfred Tylor, of Carshalton, in Surrey. He had not long joined our body, but, as appeared from the paper which he read to us three years ago, he was much interested in questions which affect the

recent geology of this county. Mr. Alfred Tylor was a frequent attendant at the meetings of the Geological Society of London, where he brought forward papers on subjects which he treated with a good deal of originality, especially as connected with the form and direction of river courses. He especially brought forward, with a view to explaining the great deposits of sand and gravel by comparatively small rivers, a mass of evidence to prove the existence of a much heavier rainfall during a time which succeeded the Glacial epoch, and which he termed the Pluvial period. Mr. Tylor devoted himself to geology from pure love of the science, having been for a great part of his life chained to active business at his family's London manufactory of copper and brass work; and we have reason to believe that in this sphere of industry he was eminently well-informed and successful—another example of the happy way in which a man of business may profitably employ his intervals of leisure in the cultivation of geological science.

6th November, 1885.

REPORT OF THE COUNCIL.

In presenting their Seventy-second Annual Report, the Council have again the pleasant duty of recording progress, and of assuring the Members of the continued well-being of the Society.

Donations to the Museum have not been numerous of late years. Some few specimens of particular interest have, however, been added to the cabinets during the past twelve months, as you will learn more particularly from the report of your Curators.

In the Library a steady increase of books has involved the necessity of putting up a new book-case, and a considerable sum has been spent in binding. Your Librarian will inform you more particularly of the many volumes presented or purchased during the past year.

The Science Classes, carried on by Messrs. Barnett and Corin, under the sanction of this Society, in the classrooms in the basement of this building, continue their useful course; and the Council desire especially to recommend them to the attention of the public as a means of acquiring valuable information.

The Council having considered the subject of the possible spread of fire to this building, in case of a conflagration in St. John's Hall, have determined upon raising the party wall through the roof to a sufficient height to ensure safety.

It is with very sincere regret that the Council refer to the loss the Society has sustained in the death of one honorary and two ordinary members during the past year. Mr. Thos. Davidson, F.R.S., well known in the scientific world; Mr. Alfred Lloyd Fox, many years a member of this Society; and Mr. Alfred Tylor, a contributor to its Transactions.

The Council in conclusion desire to recommend the election of the Rev. Canon Rogers, vicar of Gwennap, and of Mr. Solly, of Cambridge, as ordinary members of the Society.

LIBRARIAN'S REPORT.

The following works have been added to the Library:

I. TRANSACTIONS, JOURNALS, AND REPORTS.

Presented by the respective Societies, Editors, and other Donors, or purchased.

Anglesea, Brecon, &c. Dr. C. Le Neve Foster's Report upon the Inspection of Mines classed under the Metalliferous Mines Regulation Acts in the Counties of Anglesea, Brecon, Cardigan, Carnarvon, Denbigh, Flint, Merioneth, Montgomery, Radnor, and Shropshire, and in the Isle of Man, for the year 1884. Folio. [London], 1885.

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Proceedings: Vol. xii., May, 1884, to May, 1885. 8vo. Boston, 1885.

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Dorpat. Dorpater Naturforscher-Gesellschaft. Archiv für die Naturkunde Liv-, Esth- und Kurlands:
II. Serie. Band x., lief. 1. 8vo. Dorpat, 1884.
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Dublin, 1884–85.

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——. Fossil Echinoidea from the Gáj or Miocene Series. [Series xiv. Vol. i., part 3, fasc. 5.]

Lydekker: The Labyrinthodont from the Bijori Group. [Series iv. Vol. i., part 4.]

——. The Reptilia and Amphibia of the Maleri and Denwa Groups. [Series iv. Vol. i., part 5.]

——. Mastodon Teeth from Perim Island. [Series x. Vol. iii., part 5.]

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[Presented by Dr. C. Le Neve Foster.]

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[Three photographs to illustrate the above.]

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CURATORS' REPORT.

NAME AND LOCALITY.	DONOR.
White Iron Pyrites. Small Crystal in Llanberis Cambrian Slate. It has discharged the purple colour of the slate, and caused an oval grey spot .	W. W. Smyth.
Amethystine Quartz. Ballowall, St. Just . .	J. T. Leathan.
"Tourmaline Granite," or rock resembling Luxulyanite. Nanjulyan, St. Just . . .	"
Porphyritic Granite. Nanjulyan, St. Just . .	"
Highly Felspathic Granite, containing much dark mica in large scales. Wheal Castle, St. Just .	"
Rock resembling "Trowlesworthite." St. Just United Mines	"
So-called "Black Quartz." Quartz Crystals, mixed with and inclosing Crystals of Schorl. Near Balleswidden, St. Just	"
Fibrous Hematite ("Wood Iron"). Perseverance Iron Mine, near Shakemantle, Forest of Dean .	Thos. Smith, per W. A. Taylor.
Rich Silver Ore. Pinos Altos Mine, Chihuahua, Northern Mexico	J. H. Collins.
Specimen exhibiting Vein of Bismuth Silver in Pyrites. Candameña, Chihuahua, Mexico . .	"
Clay Slate, with markings of curious organisms. Bolingey, Perran	"
Posidonomya Becheri. Rio Tinto Mines, Spain. Four specimens	"
Goniatite in Slate. Rio Tinto . . .	"

TREASURER'S STATEMENT, 1884-85.

Dr. *The Treasurer in Account with the Royal Geological Society of Cornwall.* **Cr.**

November, 1884.	£	s.	d.
To Balance	36	7	7
November, 1885.			
To Donation from H.R.H. the Prince of Wales	20	0	0
,, Ordinary Subscriptions and Arrears	73	10	0
,, Natural History and Antiquarian Society for Gas consumed	2	8	0
	£132	5	7

November, 1885.	£	s.	d.
By Rates and Taxes	0	8	0
,, Housekeeper	6	10	0
,, Assistant Curator	18	15	0
,, Insurance	2	12	9
,, Subscription to Palæontographical Society	1	1	0
,, Books, Binding, Printing, and Stationery	51	19	0
,, Sundry Bills	16	1	0
,, New Book-case	12	5	0
,, Expenses, per Secretary and Treasurer	10	0	0
,, Balance	12	13	10
	£132	5	7

W. BOLITHO, JUN.,
Treasurer.

6th November, 1885.

LIST OF PAPERS READ AT THE ANNUAL MEETING,

6th November, 1885.

1. Additional Notes on the Foraminifera of the St. Erth Clay. By Fortescue William Millett.

2. On the Abrading Action of a Stone kept in Motion by a Current of Water. By Fortescue William Millett.

3. The Cornish Trias. By R. N. Worth, F.G.S.

4. On Apatite from Levant Mine, Cornwall. By R. H. Solly, F.G.S.

sulphides, which have subsequently been more or less entirely converted into oxidised compounds in the same way as the Cornish gossans.

It may not generally be known that in some places rich gold ore occurs. The specimen which I send came from the Lilian mine, which lies about three miles south-east of Leadville, and some 800 feet above it, or at a total elevation of 11,000 feet above the sea-level. At the time of my visit, in September, gold was being found at the base of the porphyry, or, in other words, at the very top of the ore-body. The gold is generally in the form of thin plates, and the quantity obtained is already of some importance.

ADDITIONAL NOTES ON THE FORAMINIFERA OF THE ST. ERTH CLAY.

By Fortescue William Millett.

A continued investigation of the microzoa of the St. Erth clay beds shows that they are even more interesting than was at first supposed.

The long list of foraminifera appended is by no means exhaustive; for even if no more new forms are discovered, there are many doubtful specimens laid aside, waiting until more characteristic individuals present themselves to indicate their affinities. There are also some new species which have not yet been named.

Every day the difficulty of ascertaining the age of any particular bed, by the foraminifera it contains, becomes more evident; for rarely does it happen that an investigation is made of any deposit, recent or fossil, which does not extend our knowledge of the existence of several species in localities or periods where they were before unknown. Thus in this presumably Pliocene deposit we have forms which hitherto have been known to exist only in Eocene or Miocene periods. Whilst, on the other hand, there are several species which, now living in the seas in

various parts of the world, are here for the first time found fossil.

Of these latter, four species were first brought to light by the voyage of the "Challenger," and are described and figured by Mr. H. B. Brady in his great work on the foraminifera of that expedition. Of these species *Bolivina tortuosa* and *B. robusta* have been found living at various depths in the seas of both hemispheres. The first occurs sparingly, the other abundantly, in the St. Erth clay. *Discorbina patelliformis* has been found in the Pacific, and at Malta, Ceylon, and other places. The fourth species, *Truncatulina tenuimargo*, has its home in the southern hemisphere.

There are two more forms, now for the first time recorded as fossil—*Cassidulina bradyi*, Norman—which occurs in the North Atlantic, and North and South Pacific; and *Rotalia dentata* (Parker and Jones), found in the mud of Bombay Harbour.

Other species worthy of notice are *Miliolina agglutinans*, which has hitherto been found fossil only in the Post-tertiary clays of Norway and Scotland; *Textularia quadrilatera*, found by Schwager in the Pliocene of Kar Nicobar; and *Spirillina vivipara*, which is rare in the fossil state.

In conclusion, it may be mentioned that the shells of some of the larger specimens of *Discorbina parisiensis* still contain the sarcode, dried up and contracted, but apparently otherwise unaltered; thus differing from the "molluskite" of Dr. Mantell's Chalk and Flint foraminifera.

LIST OF FORAMINIFERA

FROM THE CLAY OF ST. ERTH.

Cornuspira involvens, *Reuss.*
foliacea, *Philippi*, sp.
Biloculina ringens, *Lamarck*, sp.
Miliolina tricarinata, *d'Orb*, sp.
trigonula, *Lamarck*, sp.
oblonga, *Montagu*, sp.
seminulum, *Linn.*, sp.
secans, *d'Orb.*
subrotunda, *Montagu*, sp.
bicornis, *Walker and Jacob*, sp.
ferussacii, *d'Orb.*
sclerotica, *Karrer.*
undosa, *Karrer.*
agglutinans, *d'Orb*, sp.
Spiroloculina limbata, *d'Orb.*
excavata, *d'Orb.*
Textularia saggitula, *Defrance.*
gramen, *d'Orb.*
quadrilatera, *Schwager.*
Bigenerina nodosaria, *d'Orb.*
Bulimina pupoides, *d'Orb.*
affinis, *d'Orb.*
elegantissima, *d'Orb.*
marginata, *d'Orb.*
Virgulina schreibersiana, *Czjzek.*
Bolivina punctata, *d'Orb.*
plicata, *d'Orb.*
dilatata, *Reuss.*
robusta, *Brady.*
lævigata, *Williamson*, sp.
textilarioides, *Reuss.*
Cassidulina lævigata, *d'Orb.*
oblonga, *d'Orb.*

Cassidulina crassa, *d'Orb.*
bradyi, *Norman.*
Lagena lævis, *Montagu*, sp.
clavata, *d'Orb*, sp.
gracillima, *Seguenza*, sp.
globosa, *Montagu*, sp.
apiculata, *Reuss*, sp.
striata, *d'Orb*, sp.
lineata, *Williamson*, sp.
semistriata, *Williamson*, sp.
lyellii, *Seguenza*, sp.
sulcata, *Walker and Jacob*, sp.
squamosa, *Montagu*, sp.
melo, *d'Orb*, sp.
hexagona, *Williamson*, sp.
lævigata, *Reuss*, sp.
lucida, *Williamson*, sp.
quadrata, *Williamson*, sp.
var. semialata, *Balkwill and Millett.*
acuta, *Reuss*, sp.
trigono-oblonga, *Seguenza*, sp.
marginata, *Walker and Boys*, sp.
var. with striæ, *Nov.*
seminiformis, *Schwager*, var.
lagenoides, *Williamson*, sp.
ornata, *Williamson*, sp.
trigono-marginata, *Parker and Jones.*
bicarinata, *Terquem*, sp.
orbignyana, *Seguenza*, sp.
Rhabdogonium tricarinatum, *d'Orb.*
Glandulina lævigata, *d'Orb.*
Nodosaria pyrula, *d'Orb.*
simplex, *Silvestri.*
scalaris, *Batsch.*
(Dentalina) brevis, *Reuss.*
guttifera, *d'Orb.*
Cristellaria rotulata, *Lamarck*, sp.
crepidula, *Fichtel and Moll.*
Polymorphina lactea, *Walker and Jacob.*
fistulose form.
æqualis, *d'Orb*, sp.

Polymorphina amygdaloides, *Reuss.*
oblonga, *Williamson* (not *d'Orb*).
compressa, *d'Orb.*
communis, *d'Orb.*
hirsuta, *Brady, Parker, and Jones.*
Uvigerina angulosa, *Williamson.*
Spirillina vivipara, *Ehrenberg.*
Globigerina bulloides, *d'Orb.*
cretacea, *d'Orb.*
Discorbina turbo, *d'Orb*, sp.
globularis, *d'Orb*, sp.
rosacea, *d'Orb*, sp.
orbicularis, *Terquem*, sp.
patelliformis, *Brady.*
parisiensis, *d'Orb*, sp.
wrightii, *Brady.*
Planorbulina mediterranensis, *d'Orb.*
Truncatulina lobatula, *Walker and Jacob*, sp.
variabilis, *d'Orb.*
tenuimargo, *Brady.*
haidingerii, *d'Orb*, sp.
ungeriana, *d'Orb*, sp.
Pulvinulina auricula, *Fichtel and Moll.*, sp.
oblonga, *Williamson*, sp., var.
elegans, *d'Orb*, sp.
Rotalia beccarii, *Linn.*, sp.
punctato-granosa, *Seguenza.*
nitida, *Williamson.*
calcar, *d'Orb*, sp.
dentata, *Parker and Jones.*
Patellina corrugata, *Williamson.*
Nonionina depressula, *Walker and Jacob*, sp.
scapha, *Fichtel and Moll.*, sp.
stelligera, *d'Orb.*
umbilicatula, *Montagu*, sp.
communis, *d'Orb.*
Faujasina carinata, *d'Orb.*
Polystomella striato-punctata, *Fichtel and Moll.*, sp.
crispa, *Linn.*, sp.
macella, *Fichtel and Moll.*, sp.

ON THE

ABRADING ACTION OF A STONE KEPT IN MOTION BY A CURRENT OF WATER.

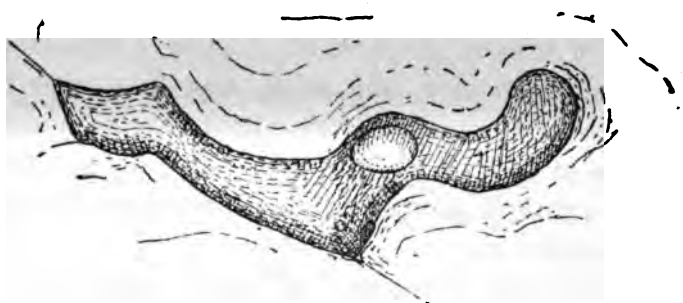
By Fortescue William Millett.

Amongst the minor agencies which tend to disintegrate the beds of rock which form the surface of the earth, scarcely sufficient attention has been paid to the action of a loose stone, which, finding a settlement in some depression, and being kept in motion by exposure to a current of water, gradually wears away the bed of rock on which it happens to find a lodgement, and in the course of time forms a smooth basin or channel.

A conspicuous example of this action may be seen in the so-called Gletscher Gärten at Lucerne, where, on a slope of the hillside, huge basins have been excavated in the solid rock, each one containing a large stone worn as round and as smooth as a cannon ball.

Close at hand we have a small but very neat example of this action. At Marazion, to the east of Top Teeb boat cove, a reef of killas stretches out into the sea, ending abruptly near low-water mark. At this point there is a sinuous channel worn in the

reef; and the smoothness of the worn surfaces, and the equal abrasion of the hard quartz veins and the soft slate, indicate that this channel has been excavated by the action of a stone kept in motion by the waves of the sea. The channel is about twelve feet long, and from twelve to eighteen inches in breadth, with a depth of three feet at the end nearer the shore. The first half appears to have followed a fault in the reef; but the other portion, which forms a beautiful serpentine curve, is excavated in the solid rock. A rounded stone now lies in one of the bends of this curve.



THE CORNISH TRIAS.

By R. N. Worth, F.G.S.

One of the most noteworthy features of the Trias of the West of England is the number and scattered character of its outliers, which indicate beyond question that originally the area occupied by the New Red rocks of this district was very much more extensive than it is now. The most south-westerly of these outliers occurs at Cawsand, on the western shore of Plymouth Sound, and thus entitles us to claim the Trias as a Cornish formation. This little patch, with another at Thurlestone, in Bigbury Bay, and a third at Slapton, in Start Bay, are the sole visible witnesses to the fact that the Triassic area of Devon extended westward along the coast from Torbay. The Slapton outlier is about ten miles from the extreme point of the Torbay Trias, the Thurlestone nearly another ten miles further; but between Thurlestone and Cawsand the distance in a straight line is fully sixteen. Outliers at Portledge and Peppercombe, in Barnstaple Bay, the most westerly of all, are much the same distance from their nearest neighbour—the outlier at Hatherleigh; and Port-

ledge and Cawsand mark the extreme western points to which the English Trias can be traced.

In laying before the Royal Geological Society of Cornwall an account of the Cawsand Trias, I am but fulfilling a task imposed by one of its most zealous members fifty-five years ago. Dr. Boase, in his account of the Eastern Geology of Cornwall, published in the fourth volume of the *Transactions* of this Society, apologizing for his inability to give to the Mount Edgcumbe district the attention its importance deserved, remarked: "It is therefore to be hoped that the members of the Plymouth Institution will continue this enquiry, until it is successfully elucidated." It is not for me to suggest that success has now been attained, but an attempt to elucidate the most interesting feature of the geology of the area indicated is here made.

Dr. Boase does not seem to have recognized the existence of the Cawsand Trias in any way. The rocks described by him in Cawsand Bay, with the exception of a Devonian red sandstone, are said to be of the same nature as those which occur between Polbathick and Torpoint. And yet it is difficult to understand that he is not speaking of the felspathic trap of this locality when he mentions a red rock speckled with white, though it is not easy to see how he could compare this rock with the greenstone of Saltash and St. Germans. Dr. Boase's observations were published in 1830, and in the same year there

appeared in the first volume of the *Transactions of the Plymouth Institution* a description of the geology of the country near Plymouth by Mr. John Prideaux. He also, though an excellent mineralogist and able man of science, failed to recognize the distinctive features of the Cawsand rocks. It is clear, however, that the felspathic trap already mentioned did come under his notice; for he speaks of the Cawsand Bay *sandstone* as a "deeper red than the Bovisand, as having little cavities, some filled with white nodules, and as being variegated and interlined in places with this same white substance, looking not unlike mortar." This is a very fair description of much of the general aspect of the trap, but of the trap only.

As far as I am aware, the first observer to suggest the true character of this rock, and to associate it by its lithological characters with the Trias, was Sir Henry de la Beche, who, in his well-known *Report on Cornwall, Devon, and West Somerset*, says:*

"A porphyritic rock occurs at Cawsand, in Plymouth Sound, ranging thence towards Redding Point, which in general aspect resembles some of the igneous rocks associated with this [the New Red Sandstone] series in the neighbourhood of Exeter and Tiverton. . . . Though unable to adduce direct proof, we are inclined to refer this porphyry from its general character to the date of the lower part of the red sandstone series."

And here the matter practically rested until, in

* Page 211.

1867, Mr. W. Pengelly, F.R.S., announced that his attention had been called by Mr. Reading, then of Plymouth, to a patch of undoubted Triassic conglomerate on the beach at Cawsand, in immediate juxtaposition to the trap, thus affording as much of the direct proof desired by Sir Henry de la Beche as could possibly be expected. There had been a very general agreement that Sir Henry was right in regarding this trap as Triassic, but the conglomerate was the first true Trias found; and the wonder seems rather, not that it was at length identified, but that it had not been discovered long before. Sir Henry, at any rate, must have visited the locality at low-tide.

My interest in the subject was specially aroused in connection with the petrology of Plymouth; and having had examples of the trap sliced for microscopical examination, it occurred to me that, in offering the results to the Society, it might be well also to put upon record what is known touching the Cornish Trias.

The conglomerate, or, more properly speaking, breccia, was identified by Mr. Pengelly as "having the colour and general characters of the Torbay Trias."* It is simply a low flat beach reef, extending seaward from near the base of the cliff to the low-water line, and how far beyond it is not easy to say. It does not average more than seventy yards in width, and the full low-tide exposure is barely two-thirds of an acre. Moreover, under the incessant

* *Trans. Devon. Assoc.* vol. ix. p. 418.

grinding of the waves it is steadily and in parts perceptibly wasting away. The constituent fragments are composed of the older rocks of the district—the Devonian limestones, sandstones, and schists, with traps. In fact it presents precisely the same general characters as the ordinary Triassic conglomerates of the county elsewhere.

There is some further evidence of the extension of the Trias in this locality. A large block of breccia on the beach at Drake's Island, weighing probably four or five tons, has not only a Triassic aspect, but, from its position among other blocks, and its untravelled character, appears to be the last remnant of an insular patch. Veins of fine red sandstone in the joints of the Plymouth limestone, wholly differing from the true Devonian sandstones, also suggest a like origin. Moreover, Mr. Ussher has pointed out the striking resemblance borne by the "head" between Cawsand and Picklecombe to "unconsolidated Triassic breccia,"* and it seems to me probable that we are here dealing with redeposited Triassic *débris*—at least in part.

There is also evidence of Triassic remnants in the Channel, which I hope will very shortly be made more complete. Thus much is certain, that Triassic sandstone has been found in the Channel, several miles from the Cornish shore, under conditions

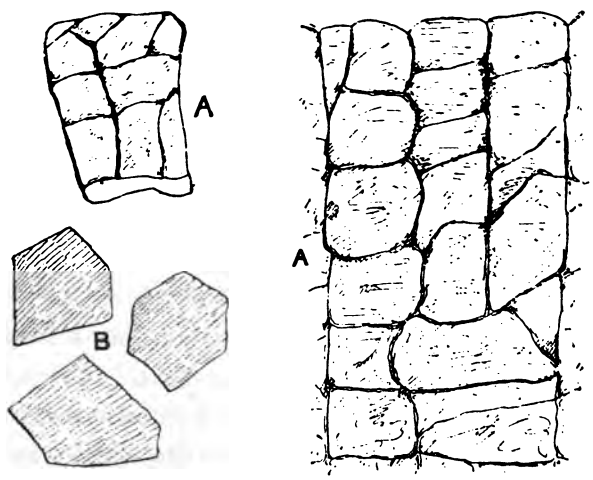
* *Trans. Roy. Geo. Soc. Corn.* vol. x. p. 64.

that seem to point to the existence of a submarine outlier associated with this county.

The Cawsand Triassic trap in mass extends from the cliff back into the high land of Maker. It is approximately triangular in area, about a mile in greatest length, a third of a mile in greatest width, and it occupies the sea front of Cawsand Bay for nearly half a mile. These are the dimensions as set forth by De la Beche, but if we take into consideration the extent to which it ramifies from the main boss through the adjacent rocks, we must assign to it a much greater extent and wider influence. It occurs in mass, in dykes, and in veins, and some of the latter have extended to Millbrook and into Whitesand Bay. There can be no question about its intrusive character. It appears to have thrust the Devonian grits on the north somewhat to the northward of their normal strike, and not only has it greatly disturbed the strata in its immediate vicinity, but it has produced considerable contact changes, silicifying the slates, and rendering the sandstones more compactly quartzose. There seems good reason to assign to this intrusion some of the leading outlines of the present configuration of the Plymouth water area.

The most remarkable external feature of this rock is its casual but well-marked columnar character, which is noticed on the Ordnance Survey map, but has never attracted the attention its interest and

importance deserve, probably from the fact that it is only at full ebb-tides that it can be fully appreciated. This structure is imperfectly shown also in a concretionary aspect. The latter point is noticed by Sir Henry De la Beche in his *Report;* but he there passes by the columnar phenomenon, although he observes that some of the veins are affected by cleavage.



A Elevation of columnar structure. B Sections of columns.

The rock is described by De la Beche as "a somewhat earthy compound of felspar and quartz, containing crystals of mica and more rarely of felspar, of a reddish colour in the mass, mixed with occasional bluish-green spots."* This requires to be supplemented somewhat considerably. The earthy texture is characteristic of the bulk of the rock; but while on the one hand it passes into friable or schistose varieties,

* *Report Geo. Corn. Dev. and West Som.* p. 211.

on the other it assumes a very compact form with a dull, waxy lustre, and even approximates in parts to the condition of pitchstone, the vitreous aspect being sometimes strongly marked. The colour varies in the mass from deep brown-red to a lighter brick-red, and occasionally there is a purplish shade. The variegations noted I should describe as generally of a greenish, but sometimes of a tawny, grey; and many of the veins are of this character. The red hue is no doubt due to the presence of iron, and the idea seems suggested that in the lighter parts this colouring has been discharged.

The rock is slightly and casually vesicular, and some of the vesicles are lined with a white crust. The felspar crystals, so far as they are observable by the naked eye, are in great part kaolinised, though quite numerous and prominent enough to give the rock its porphyritic aspect. A black or dark-brown mica is plentiful, and in some examples forms so large a proportion of the whole rock as fairly to entitle it to the name of a mica trap. As compared with the Triassic traps of the Exeter district the Cawsand rock most nearly resembles as a rule that of Pocombe, though less crystalline in texture, while some of the grey micaceous patches are hardly distinguishable in hand specimens from that of Killerton.

I have had sections of this rock cut for microscopical examination, both from the more compact variety and from the common earthy kind, which however, notwithstanding its aspect, was hard and solid.

The microscope confirms the originally vitreous character of the first of these. Fluidal structure is clearly shown, and most of the scales of mica appear to be arranged linearly to the lines of flow. Such of the scales as have their planes parallel to the section are apparently a light brown, and are fairly dichroic. Their character, however, is obscured by the red colouring matter of the rock, which has a generally flocculent and patchy appearance. Occasionally the patches have a somewhat definite outline, and may represent imperfect crystals. This colouring matter (ferrite) is opaque. A few very small clear specks are seen when the Nicols are crossed, which are probably granules of felspar.

The section from the rough-textured variety does not indicate the same vitreous character, nor is the slide so much obscured by the colouring matter. Mica is seen to form a much larger proportion of the constituents than would be gathered from macroscopic observation. It is of various shades of brown, chiefly dark, and strongly dichroic. Felspar crystals have been well developed, but show considerable alteration. Some have been replaced by felsitic matter, which gives the characteristic mosaic under polarized light. Others are made up of felspar granules. Felsitic matter also occurs in little veins. A nest of these felspar pseudomorphs is seen enclosing several flakes of mica, and broken by strings of the colouring matter. In another part of the slide there is obscurely apparent a kind of

cellular structure, the opaque colouring matter forming a (segregative?) network, the interstices of which show the ordinary ground mass of the rock. There are two well-marked crystals of ilmenite. It seems to me a question how far the difference between this section and the first can be assigned to devitrification. Changes have taken place, but there appears to have always been a distinctive character.

That the rock may fairly be called a felsite—following Professor Bonney's suggested classification—seems clear enough, but it is not so easy to define it further. The columnar structure is usually, but not always, associated with basalt, which some of the other local Triassic traps undoubtedly are. The present earthy aspect and meagre feel of the mass is rather trachytic, and the more vitreous portions may lend themselves to either interpretation.

NOTE.—Since this paper was read, the existence of a submarine Triassic outlier off the Cornish coast has been definitely ascertained. By the kindness of Mr. Matthias Dunn, of Mevagissey, I have been put in possession of a number of rock specimens brought up by the "long lines" of the Channel fishermen, which are not only plainly Triassic, but Triassic so distinctly charactered and varied as to enable me to identify them as resembling the Devon Keuper. Most of the specimens are slabs, the upper face of which has been bored, while the lower is intact, and which were evidently *in situ* when entangled with the lines. They include examples of fine red and grey and mottled sandstones, chocolate marlstone, a fine-grained micaceous

"mudstone"—grey passing into red, a trap closely allied to those of Cawsand and Thorverton, and a "potato stone" with a nucleus of pinkish calcite, exactly similar to others found in the Keuper of East Devon. The position of this outlier is fairly settled by the bearings Mr. Dunn kindly supplied with the specimens, which were brought up at several different times, and from several different positions. It lies, centrally, some dozen miles S.E. of the Lizard; but probably extends over an area of several miles. I consider myself very fortunate in being able to adduce such clear and definite evidence of what, a few months since, I had only suspected.

APATITE FROM LEVANT MINE, CORNWALL.

By R. H. Solly, F.G.S.

These crystals of apatite closely resemble the variety of apatite known as Francolite. This mineral was first described by Mr. Henry in *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, February, 1850.

"Mr. Brooke some years since received from Mr. Nuttall some specimens of a mineral found at Wheal Franco, near Tavistock, Devon, which appeared to him [Mr. Henry] and to Mr. Brooke to differ in external characters from all the substances with which they were acquainted, and it was consequently provisionally named Francolite."

The crystals consist of small aggregations of irregularly-formed hexagonal prisms, limpid, and with fair lustre, forming small irregular botryoidal masses.

Specimens purer and larger from Fowey Consols were analysed by Mr. Henry with the following result:

	A.		B.
Phosphoric Acid . . .	41·34	...	41·80
Lime	53·38	...	52·81
Protoxide of Iron and Manganese .	2·96	...	3.22
Fluorine and Loss . . .	2·32	...	2·17
Chlorine	trace	...	trace

"This composition," he says, "corresponds very nearly to that of fluor apatite, Ca F_2+3 (3 Ca O PO_5), in which the lime is partially replaced by the protoxides of iron and manganese."

The next mention of this mineral is by Greg and Lettsom in their *Manual of Mineralogy*, 1858.

"At Fowey Consols, Cornwall, recently, the variety called Francolite has been met with. It occurs in minute crystals, slightly curved, in small stalactitic, crystallised masses, and in thin plates, associated with quartz and chalcopyrite, white and translucent. It has been found also at this locality in thin, hollow cubes above an inch square, which, when first discovered, are half filled with a transparent fluid. This variety was termed Francolite, from having been found originally at Wheal Franco, near Tavistock."

In the *Journal of the Chemical Society*, vol. ix. 1871, page 3, Professor Maskelyne and Dr. Flight publish a paper with the title "Francolite."

These specimens were brought to the British Museum by Mr. Talling as from a new locality, and it was not till some time afterwards that they were found to have come from the old locality, Fowey Consols.

The crystals are deposited upon a matrix of quartz and chlorite, in the form of hexagonal prisms, with basal plane slightly modified. The measurements obtained from the latter faces differed as much as 40′ from the calculated values given by Professor Miller for apatite, but Professor Maskelyne did not consider the measurements obtained reliable enough

to give to these crystals a different element, or to assign indices to the doubtful faces.

Dr. Flight, who made the analysis, found it to be a fluor apatite, in which one equivalent in every six of the calcium phosphate is replaced by carbonate.

The following are the mean analytical results obtained:

Tri-calcium Phosphate	83·61
Calcium Fluoride	7.683
Calcium Carbonate	5·104
Iron and Manganese Oxide . . .	0·913
Sodium Oxide	0·694
Water	1·593
	99·248

The ratio points to the following formula:

$$\left.\begin{matrix} 5\,[Ca_3(PO_4)_2] \\ Ca\,Co_3 \end{matrix}\right\} + 2\,Ca\,F_2.$$

Dr. Flight further remarks that he has found $Ca\,CO_3$ in the Wheal Franco and Fowey Consols specimens.

Schrauf, in his *Mineralogische Beobachtungen*, July, 1870, describes some crystals of Francolite from Fowey Consols. The crystals are similar to those described above; but he gives a drawing, and assigns the indices (116) to the narrow, ill-defined plane lying between the basal and prism planes.

These specimens, to which I wish to draw the attention of the Royal Geological Society of Cornwall, were found lately in the deep workings of Levant Mine, St. Just. The matrix is ironstained massive quartz, with a little copper pyrites, hæmatite,

and earthy red ochre. The crystals of apatite are small, well-defined hexagonal plates, rarely an eighth of an inch in size, aggregated together as if twinned, and closely resembling in habit, lustre, and limpidness the Francolites described above.

They are closely associated in the matrix with rosette-shaped groups of flat, milky-white calcite crystals.

Mr. Robinson, of the Cambridge University Chemical Laboratory, has kindly made a careful analysis of a number of crystals, which I picked out under a microscope, so that no calcite or other impurity should be present.

A qualitative analysis gave him lime, phosphoric acid, fluorine, carbonic acid, a little iron, manganese, &c.

A quantitative analysis was made of 1456·9 milgrms.

Ca O found	= 815·9	= 56·00	per cent.
CO_2 „	= 26·8	= 1·84	„
P_2O_5 „	= 591·03	= 40·56	„
Fluorine, &c., by difference	= 23·17	= 1·20	„
	1456·9	100·0	„

This would give:

$Ca\ Co_3$	87·96	= 6·04	per cent.
$Ca_3\ 2PO_4$	1290·27	= 88·6	„
$Ca\ F_2$	78·00	= 5·36	„
	1456·23	100·00	

The amount of carbonic acid found by Flight in two specimens was 2·414 and 2·079, while that found by Robinson was 1·84.

There can be no doubt that the Levant specimens, like those from Fowey Consols, contain calcium carbonate as an essential constituent. It will thus be seen that these Levant specimens may be classed under the variety of apatite known as Francolite.

Mineralogical Museum, Cambridge.

Contents.

TRANSACTIONS.

PAGE

Preliminary Note on the Stratigraphy of West Cornwall. By J. H. Collins, F.G.S. (Illustrated) 1

On a Rock resembling Luxullianite from St. Just; and on some Globular Masses of Schorl-rock from Ding Dong Mine. By C. Le Neve Foster, D.Sc. F.G.S. 8

Observations on Balleswidden Mine. By Captain T. P. Rowe and Dr. C. Le Neve Foster, D.Sc., F.G.S. . . . 10

On the Rock-Salt and Carnallite Deposits of Stassfurt and Neighbourhood, near Magdeburg. By Joseph Garland, F.G.S. . 18

Notes on the Van Mine. By C. Le Neve Foster, D.Sc., F.G.S. (Illustrated) 33

On the Geological Structure of the Northern Part of the Meneage Peninsula. By J. H. Collins, F.G.S. (Illustrated) . . 47

On the Recent Geology of the Cornish Coast near Padstow. By W. A. E. Ussher, F.G.S. (Abstract; Illustrated.) . . 58

Pleistocene Notes on the Cornish Coast between Plymouth and Looe. By W. A. E. Ussher, F.G.S. 63

The Devonian Rocks between Plymouth and East Looe. By W. A. E. Ussher, F.G.S. (Illustrated) 70

On the Occurrence of Feather Ore (Plumosite) in Foxdale Mine, Isle of Man. By Warington W. Smyth, F.R.S. . . . 82

On Fossils from the Rocks of Cornwall, some of them New to the List. By C. W. Peach, A.L.S., F.R.P.S. Edin. . . . 90

On the Occurrence of Stanniferous Deer-horns in the Tin-gravels of Cornwall. By J. H. Collins, F.G.S. . . . 98

Note on the Supposed Serpentine of the Parish of St. Veep. By J. H. Collins, F.G.S. 101

Notes on the Geology of the South-east Border of Cornwall. By R. N. Worth, F.G.S. 103

On the Occurrence of Cobalt Ore in Flintshire. By C. Le Neve Foster, D.Sc., F.G.S. (Illustrated) 107

Description of Besshi Copper Mine, in Japan. By R. J. Frecheville 113

The Duchy Peru Lode, Perranzabuloe. By Warington W. Smyth, F.R.S. (Illustrated) 120

Contents.

PAGE

The Evidence of Glacial Action in Cornwall and Devon. By Nicholas Whitley, C.E. (Illustrated) 132

On a New Method of Ventilating Ends by Compressed Air. By W. Teague, jun., A.I.C.E. (Illustrated) 142

Notes on the Great Main Lode of Dolcoath, Cook's Kitchen, Tincroft, and Carn Brea Mines. By R. J. Frecheville, A.I.C.E. (Illustrated) 146

On the Mines of the Province of Dio Grande Do Sul, Brazil. By Henry Eddy 157

On the Nickeliferous Pyrites of Berg Nickel Mine, in the Island of Senjen, Norway. By Joseph Garland, F.G.S. . . 161

Notes on some Teeth from a Stonehouse Bone Cave. By R. N. Worth, F.G.S. 165

Notes on Aberllefenny Slate Mine. By C. Le Neve Foster, D.Sc., F.G.S. (Illustrated) 169

An Emanation of Carbonic Acid Gas at Foxdale Mine, in the Isle of Man. By C. Le Neve Foster, D.Sc., F.G.S. . . . 175

On Trowlesworthite and certain Granitoid Rocks near Plymouth. By R. N. Worth, F.G.S. 177

On the Microscopic Structure of Trowlesworthite. By Professor T. G. Bonney, D.Sc., F.R.S., F.G.S. 180

On the Ancient Metallurgy of Cornwall. By A. Tylor, F.G.S. (Abstract) 187

On the Occurrence of Volcanic Tuffs, Breccia, &c., in the Meneage District. By Alexander Somervail and Howard Fox. (Illus.) 189

The Raised Beaches on Plymouth Hoe. By R. N. Worth, F.G.S. (Illustrated) 204

Notes on the Fossil Foraminifera of the St. Erth Clay Pits. By Fortescue William Millett 213

The Umber Deposits at Ashburton. By R. J. Frecheville, F.G.S. 217

Note to Accompany a Specimen of Native Gold from Leadville, Colorado. By C. Le Neve Foster, D.Sc., F.G.S. . . . 220

Additional Notes on the Foraminifera of the St. Erth Clay Pits. By Fortescue W. Millett 222

On the Abrading Action of a Stone kept in Motion by a Current of Water. By Fortescue W. Millett. (Illustrated) . . 227

The Cornish Trias. By R. N. Worth, F.G.S. (Illustrated) . . 229

Apatite from Levant Mine, Cornwall. By R. H. Solly, F.G.S. . 240

INDEX.

PAGE

Aberllefenny Slate Mine 169
Abrading Action of a Stone kept in Motion by a Current of Water 227
Anhydrite 23
Apatite from Levant Mine 240
Arragonite at Treworgans 4
Asbolane 108
Ashburton, Umber Deposits at 217

Balleswidden Mine 10
„ Awboy's Lode 11
„ South Lode 13
„ New Lode 13
„ Pie Lodes 14
„ Cross Courses 14
„ Slides 15
„ Spar Lode 15
„ Clay Course 15
„ Produce of 17
Berg Nickel Mine 161
Besshi Copper Mine, Japan 113
Blende at Duchy Peru 124
Blown Sands at St. Enodock 59
Bojarrow, Manaccan, Tubular Cavities at 51
"Bomb" at Carne, Meneage 195
Bone Cave at Stonehouse 164
Bonney, T. G., on Trowlesworthite 180
Boulder Clay in Cardiganshire 135
Boulder Clay in Cornwall 138
Breccias and Tuffs 189

Camborne Vean 148
Cambrian or Pre-Silurian Rocks in West Cornwall 6
Caradoc Rocks in Cornwall 5, 51, 191

PAGE

Carbonic Acid Gas at Foxdale Mine 175
Cardiganshire, Glacial Phenomena in 135
Carnallite 22, 25
Carn Brea Mine 152
Carne, Meneage, Rocks at 195
Cawsand Bay, Trias at 229
Chapple's Lode 151
Clay-pits at St. Erth 138
Cobalt Ore in Flintshire 107
Collins, J. H., on the Stratigraphy of West Cornwall . . 1
" " the Geological Structure of the Northern part of the Meneage Peninsula . . . 47
" " Stanniferous Deer-horns in Cornwall . . 98
" " the Supposed Serpentine of St. Veep . . 101
Colorado, Gold from 220
Conglomerate at Nare Point 54
Cook's Kitchen 151
Copper Smelting in Japan 117
Cost of Raising and Dressing Tin-Stuff 144
Crousa Downs, Gravel at 139

Deer Park Mine 122
Ding-Dong Mine, Schorl Rock at 9
Dolcoath 148
Doombar Sands 59
Douglashall Carnallite Mine 29
Downderry 67, 77
Drift Gravel in Cornwall and Devon 133
Drift Gravel on Plymouth Hoe 140
Duchy Peru Lode 120
Dunkin's Lode 151

East Looe, Rocks at 77
East Wheal Rose 122
Eddy, Henry, on the Mines of Rio Grande do Sul, Brazil . . 157
Eddystone and Shovel Reef Gneisses 103

Fahlerz at Foxdale Mine 86
Favosites fibrosa 90
Feather Ore in Foxdale Mine 82
Feder-Erz 82
Flushing Cove, Rocks of 196
Foel Hiraddug Mine 107
Foraminifera of St. Erth 213, 222

PAGE

Fossils in Cornish Rocks 3, 4, 5, 49, 51, 52, 56, 75, 78, 90-97, 141, 213, 222
FOSTER, C. LE NEVE, on a Rock Resembling Luxullianite . . 8
„ „ Globular Schorl Rock . . . 9
„ „ (and Capt. Rowe) Balleswidden Mine . 10
„ „ Notes on the Van Mine . . . 33
„ „ Cobalt Ore in Flintshire . . . 107
„ „ Aberllefenny Slate Mine . . . 169
„ „ an Emanation of Carbonic Acid Gas at Foxdale Mine 176
„ „ Native Gold from Leadville, Colorado . 220
FOX, HOWARD (and Alexander Somervail), on the Occurrence of Volcanic Tuffs, Breccia, &c., in the Meneage District . . 189
Foxdale Mine 82, 175
Fragmentary Rocks at Gerrans Bay 4
Francolite 240
FRECHEVILLE, R. J., Description of Besshi Copper Mine, Japan . 113
„ „ on the Great Main Lode of Dolcoath, Cook's Kitchen, Carn Brea, and Tincroft . . 146
„ „ on Umber Deposits at Ashburton . . 217

GARLAND, JOSEPH, on the Rock Salt and Carnallite Deposits of Magdeburg 18
„ „ on the Nickeliferous Pyrites of Berg Nickel Mine, Norway 161
Gerrans Bay, Millerite at 5
„ Rocks at 4, 5
Glacial Action in Cornwall and Devon 132
Gneiss in Cornwall 103
Godrevy, Raised Beach at 134
Gold from Colorado 220
Gorran Haven, Fossils at 93
Granite at Balleswidden 12
„ Cligga Head and Carclaze 7
„ Dolcoath 150
Granitoid Rock at St. Budeaux 178
Gravel-beds in Cornwall 133
Gravel Hill Mine 122
Great Retallack Mine 121
Greenway Cliff, Raised Beach at 60
"Gries" 11
Grit Series at Maker 72, 81
„ Rame 73

"Head" on Cornish Coast 64-69
„ (cemented) at Downderry and Seaton . . . 65

PAGE

"Head" at Picklecombe 65
„ at St. Ives 126
Highburrow Lode 152
Hoe, Plymouth, "Drift" on 140

Intrusive Rocks in Meneage 54

Jamesonite 83

Kainite 27
Kieserite 24

Ladock Beds 2, 47
Lantivet Bay Fossils 91, 95
Lead Ore at the Van Mine, Produce of 45
Leadville, Colorado 220
Leopoldshall Rock- and Potash-Salt Mines . . . 21
Letcha, Luxullianite at 8
Levant Mine, Apatite from 240
Limestone at Gerrans Bay 5
„ Mount Edgcumbe 70
Lingula Squamiformis 92
Lizard, Submarine Triassic Outlier at the 238
Lodes . . . 11, 33, 84, 107, 114, 120, 146, 158, 221
Lode, Great Main, of Dolcoath, Cook's Kitchen, Carn Brea, and Tincroft 146
Looe, Rocks at 77
Lower Silurian Rocks in Cornwall 5, 48
Lower Newham, Fossils at 4
Luxullianite at Letcha, St. Just 8

Maker, Grits at 72, 81
Marazion, Abrading Action at 227
Meneage District, Geological Structure of 47
„ Volcanic Rocks in 189
Metallurgy (ancient) of Cornwall 187
Metamorphosed Stratification at Porthalla and Drawna . . 52
Millerite at Gerrans Bay 5
MILLETT, FORTESCUE WILLIAM, on the Fossil Foraminifera of the St. Erth Clay Pits . . 213
„ „ Additional Notes on . . 222
„ „ On the Abrading Action of a Stone kept in Motion by a Current of Water . . . 227
Mines 9, 10, 21, 29, 33, 82, 86, 113, 121, 122, 131, 132, 148, 151, 152, 157, 161, 169, 196, 217, 240

PAGE

Mines of Rio Grande do Sul 157
Mount and Trebisken Mines 121
Mount Edgcumbe, Limestone at 70

Nare Point, Conglomerate 54
Nare Head, Fossils at 96
Nelly's Cove, Fossil at 52
Nickeliferous Pyrites 161

Orthis Caligramma 93

Padstow, Recent Geology of 58
PEACH, C. W., on Fossils from the Rocks of Cornwall . . 90
Penlee Point, Rocks at 73
Perranzabuloe 120
Picklecombe, "Head" at 65
Pleistocene Notes on the Cornish Coast 63
Plumosite in Foxdale Mine 82
Plymouth Hoe, "Drift" on 140
„ "Raised Beach" on . . . 167, 204
Polperro, Fossils at 95
Poltesco, Fossils at 3
Polyhalite 24
Porthalla Cove, Rocks of 52
Pre-Silurian Rocks in Cornwall 3
Protovirgularia dichotoma 91
Pyrites, Nickeliferous 161

Quarternary Fauna of Cornwall 105
Quartzites in Meneage 49

"Raised Beaches" on Cornish Coast between Plymouth and Looe 64–69
„ Godrevy 134
„ Greenway Cliff 60
„ Plymouth Hoe . . . 167, 204
„ Trebetherick 59
Rame, Slates and Grits of 73
Ready Money Cove, Fossils at 92
Rio Grande do Sul, Mines of 157
ROWE, Captain T. P. (and Dr. Foster), on Balleswidden Mine . 10

Sand-bed at St. Erth 138
Scaphasphis Cornubicus 64
Schorl Rock, Globular, at Ding-Dong 9

PAGE

Seaton, "Head" at 65
Serpentine, Supposed, of St. Veep 101
Silurian Rocks in Cornwall (Upper) 2
" " " (Lower) 5, 48
Slates and Grits of Rame 73
Slate Mine of Aberllefenny 169
Smelting Nickel Ore in Norway 163
SMYTH, WARINGTON W., on Plumosite in Foxdale Mine . . 82
" " the Duchy Peru Lode . . . 120
SOLLY, R. H., on Apatite from Levant Mine . . . 240
SOMERVAIL, ALEXANDER (and Howard Fox), on the Occurrence of Volcanic Tuffs, Breccia, &c., in the Meneage District . . . 189
St. Agnes Beacon, Deposits at 139
St. Budeaux, Rock at 178
St. Enodock, Blown Sand at 59
St. Erth, Sand-Bed and Clay-Pit at 138
" Fossils at 141, 214, 222
St. Ives, "Head" at 138
St. Veep, Supposed Serpentine of 101
Stanniferous Deer-Horns 98
Stassfurt Rock- and Potash-Salt Mines 18
Stonehouse Bone Cave, Teeth from 165
Stratigraphy of West Cornwall 1
Stray Park Mine 148
Stream Tin Gravels of Cornwall 187
"Submarine Forest" at Millendreath 68
" " Doombar Sands 58
" " Ruan 63
Submarine Triassic Outlier at the Lizard 238

TEAGUE, W., jun., on a New Method of Ventilating Ends by Compressed Air 142
Tincroft 152
Tin Stuff, Cost of Raising and Dressing 144
Treamble Mine 121
Trebetherick, "Raised Beach" at 59
Treworgans, Arragonite at 4
Trias, the Cornish 229
Triassic Trap at Cawsand 230
" Breccia at Cawsand 71
" Outlier at the Lizard 238
Trowlesworthite 177, 180
Trowlesworthy Tor 176
Tubular Cavities in Quartzites 51

PAGE

Tuffs and Breccias 189
TYLER, A., on the Ancient Metallurgy of Cornwall . . . 187

Umber Deposits at Ashburton 217
Upper Silurian Rocks in Cornwall 2
USSHER, W. A. E., on the Recent Geology of the Cornish Coast near Padstow 58
" the Cornish Coast between Plymouth and Looe 63
" the Devonian Rocks between Plymouth and East Looe 70

Van, Fossils at 91
Van Mine 33
" Gas at 36
Ventilating Apparatus 142
Volcanic Rocks in Meneage District 189
" "Bomb" at Carne, Meneage 195

Wheal Hope, Fossils at 3
Wheal Jennings 131
Wheal Darlington 132
WHITLEY, NICHOLAS, on the Evidence of Glacial Action in Cornwall and Devon 132
WORTH, R. N., on the Geology of the South-east Border of Cornwall 103
" " Teeth from a Stonehouse Bone Cave . . 164
" " Trowlesworthite, and Certain Granitoid Rocks near Plymouth 177
" " the "Raised Beaches" of Plymouth Hoe . . 204
" " the Cornish Trias 229

Zundererz 87

LIST OF PLATES.

		PAGE
Sections and Plan of Balleswidden Mine (Plate I.)	*to face*	12
Sections of Van Mine (Plate II.)	„	35
„ (Plate III.)	„	37
„ (Plate IV.)	„	39
„ (Plate V.)	„	41
Sections and Sketch-map of Meneage	„	50
Longitudinal Sections of "Raised Beach" at Godrevy, St. Ives Bay; and Longitudinal Section of Sand-pit at St. Erth	„	134
Longitudinal Section of Parts of the Cliff on the West Side of St. Ives Bay; and Section from the top of the Hoe, Plymouth, to the Sea	„	140
Cross Section of Dolcoath Mine	„	149
Cross Section of Cook's Kitchen Mine	„	151
Sections of Aberllefenny Slate Mine (Plate V.)	„	170
„ „ (Plate VI.)	„	172
„ „ (Plate VII.)	„	174
Geological Map of the Meneage District	„	189

PAGE

Tuffs and Breccias 189
TYLER, A., on the Ancient Metallurgy of Cornwall . . . 187

Umber Deposits at Ashburton 217
Upper Silurian Rocks in Cornwall 2
USSHER, W. A. E., on the Recent Geology of the Cornish Coast near Padstow 58
„ the Cornish Coast between Plymouth and Looe 63
„ the Devonian Rocks between Plymouth and East Looe 70

Van, Fossils at 91
Van Mine 33
„ Gas at 36
Ventilating Apparatus 142
Volcanic Rocks in Meneage District 189
„ "Bomb" at Carne, Meneage 195

Wheal Hope, Fossils at 3
Wheal Darlington 132
Wheal Jennings 131
WHITLEY, NICHOLAS, on the Evidence of Glacial Action in Cornwall and Devon 132
WORTH, R. N., on the Geology of the South-east Border of Cornwall 103
„ „ Teeth from a Stonehouse Bone Cave . . 164
„ „ Trowlesworthite, and certain Granitoid Rocks near Plymouth 177
„ „ the "Raised Beaches" of Plymouth Hoe . . 204
„ „ the Cornish Trias 229

Zundererz 87

LIST OF PLATES.

		PAGE
Sections of Van Mine (I.) . .	*to face*	35
" (II.) . .	"	37
" IV.) . .	"	39
" V.) . .	"	41
. .	"	50
' at Godrevy, tion of Sand-	"	134
of Parts of the Cliff on the Side/or Ives Bay; and Section from the t Hoe, Plymouth, to the Sea .	"	140
Cross S of D h Mine . . .	"	149
C of C 's Kitchen Mine . .	"	151
of A ny Slate Mine (Plate V.) .	"	170
" " (Plate VI.) .	"	172
" " (Plate VII.) .	"	174
Geological Map of the Meneage District . .	"	189

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